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ABSTRACT

Presented are instructions for the use of "USPOP," a human population model which involves computer simulation. The student may manipulate variables which affect the population dynamics of the United States. Baseline data are drawn from the 1970 census. Variables which can be manipulated include fertility, age of mother at birth of child, sex ratio of offspring, and age-dependent mortality. (Author/RE)

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HUNTINGTON II Simulation Program - USPOP

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STUDENT
MANUAL

USPOP

UNITED STATES POPULATION STUDY

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HUNTINGTON TWO COMPUTER PROJECT

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13 June 1973

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USPOP

STUDENT MANUAL

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I. INTRODUCTION

When you are studying population change, you are carrying out a study in demography. *USPOP* allows you to study many aspects of the United States' human demography including population growth, age and sex distribution.

The word demography can be traced back to ancient Greek. *Demos* means people and *graphos* meaning writing or mapping. Demography was one of the first fields in biology to make use of mathematics. It had its origin in census taking and dates back as far as the early Roman Empire. Imperial Rome was interested in the census for at least two reasons. First, they needed census data in order to figure how much tax money should be collected in each area. They also used census data to assure that they would have enough young men to fill their powerful growing armies.

Today many people are interested in demography for additional reasons. In many areas of the world, human populations have reached or are nearing the limits of their resources. Large increases in population in these areas will lead to increased starvation and disease. There are even those in the United States who are concerned that we too will reach the limit of our resources in the near future.

Naturally, government is still interested in census data to calculate taxes and other programs, such as welfare, that deal with numbers of people. Every ten years the United States carries out a nationwide census, and such large amounts of data are collected that it takes several years for it to be analyzed. But in the meantime, the Government has to be able to plan ahead. In between census years, how does the United States know its population size and makeup? How can the United States plan 30 or more years into the future?

Both of these questions bring up another aspect of demography. Demography is also concerned with population projection. U.S. Government demographers must be able to estimate future populations at least 50 years into the future to enable the Government to operate efficiently and anticipate the needs of the citizens.

How do demographers go about making such a projection? The first step is to gather all of the current facts about the population to be studied. Such things as fertility, birth distribution, mortality, age and sex distribution are determined from the latest census data. In addition a series of educated guesses (or assumptions) must be made to predict changes that might happen in the future. Then using mathematical formulas and computers, projections are made on the basis of these facts and assumptions.

For example, using 1960 data, demographers made an assumption that fertility would slowly decrease to 2.5 children for each completed family, while all other factors remained the same. Using the census data and these assumptions, they projected the population for the year 2010.

Such a projection will be useful only if fertility does decrease to 2.5 children per completed family. Because of this, demographers seldom make a single projection. They generally make a series of projections, each based on different assumptions.

USPOP will allow you to make such projections and to investigate the consequences of many different demographic changes.

II. YOUR ROLE IN *USPOP*

Your teacher will assign you at least one of the *USPOP* student investigations contained in this Manual. Each investigation calls on you to be the demographer. *USPOP*'s program already has all the necessary mathematical formulas and the latest census data. You will have to supply the assumptions that attempt to predict changes that might happen in the future.

The factors that *USPOP* allows you to study are the following:

1) Fertility - the average number of children a woman can be expected to have during her life. Fertility does change from year to year, but usually only by small amounts. In 1966 fertility was equal to 2.7 children per female, and in 1967 it was 2.6 children per female. Over greater periods of time, larger changes occur. (In 1955 the fertility was 3.6 children per female.)

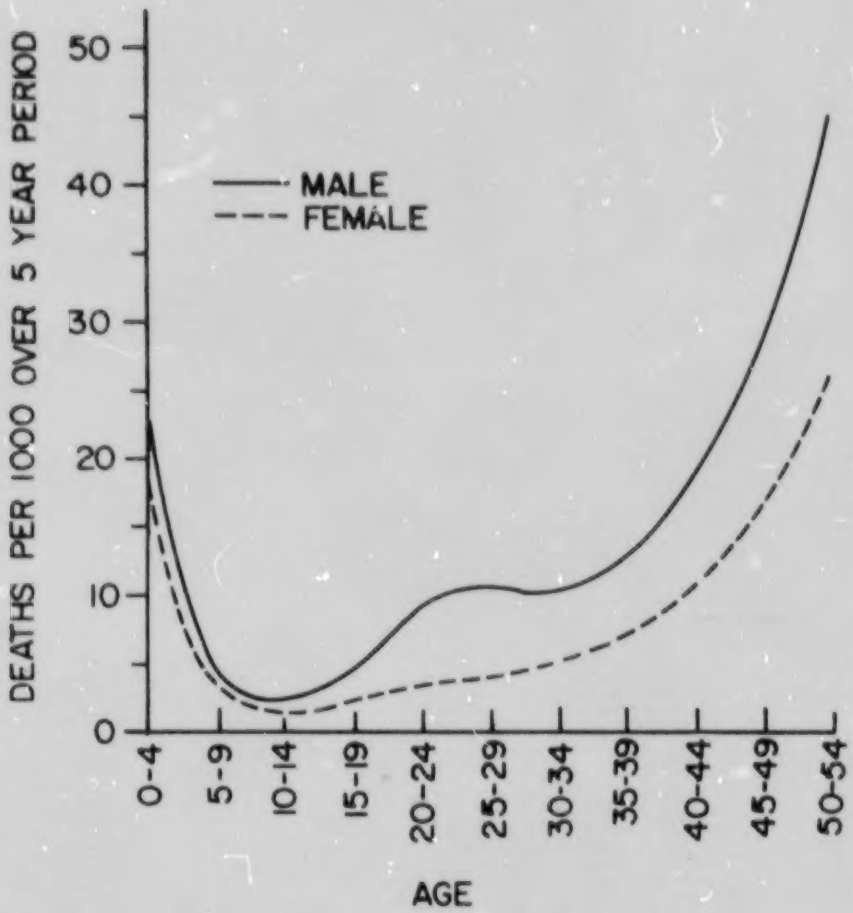
2) Birth Distribution - the ages at which females can be expected to have their children. Look at the following table:

Age	Per Cent of Total Fertility 1970
10 - 14	.2
15 - 19	14.3
20 - 24	33.8
25 - 29	28.5
30 - 34	14.7
35 - 39	6.6
40 - 44	1.8
45 and over	.1

Notice that this birth distribution predicts that women in the age group 20-24 are most likely to have children. Why do you think this might be so?

3) Sex Ratio of Offspring - today there are more males born than females. For every 200 live females born, there are 210 male offspring. Thus, only 48.7% of the children born are female. With new controls over reproduction, it may soon be possible to select the sex of your offspring. What do you think this may do to the sex ratio? You can explore this assumption with *USPOP*.

4) Mortality Rates - mortality means death. The mortality rates used in *USPOP* predict the chance that a person will die within the next five years. Below is a graph of mortality rates for males and females under 55 years of age.



As you can see, males are always more likely to die than females. Also notice that there is a higher risk of death in the very old and the very young. Does this have to remain this way? *USPOP* allows you to judge the effect of changing mortality.

5) *USPOP* also allows you to alter the size of the population. Demographers in general do not alter their populations unless they assume a war or a serious disease. Since these events are usualy hard to predict, demographers avoid making projections based on such assumptions. However, *USPOP* will allow you to make and test such assumptions if you wish.

III. USING *USPOP*'S COMPUTER PROGRAM

USPOP's computer program contains all the mathematical formulas necessary to carry out the assigned projections. It also contains the latest census data.

When you type "RUN", the computer will ask a series of questions in order to determine your assumptions. The computer will first ask:

DO YOU WANT REPORTS 1) EVERY 5 YEAR INTERVAL, OR 2) SELECTED YEARS?

In the beginning, select choice (1).

Next the computer will ask:

YEAR AT START OF PROJECTION?

If you are going to make use of the census data already stored in the program, you should type "1970". If you are basing your projection on data from another year, you should type the appropriate year.

DO YOU ASSUME STANDARD FERTILITY (1=YES, Ø=NO)?

If you wish to assume that the fertility in the first year of your project will be equal to that in 1970, type "1" (for YES). If not, type "Ø" (for NO).

WILL FERTILITY (1) REMAIN CONSTANT OR (2) CHANGE SLOWLY TO A NEW LEVEL?

Select the number that best represents your assumption as to what will happen to fertility in the future.

DO YOU ASSUME STANDARD BIRTH DISTRIBUTION (1=YES, Ø=NO)?

If you assume that the birth distribution will remain close to 1970 levels, then you should type "1" (for YES). If you assume that the birth distribution will change, type "Ø", and the computer will ask you to type in the new distribution you assume.

DO YOU ASSUME STANDARD SEX RATIO (1=YES, Ø=NO)?

If you assume that the sex ratio in your projection is equal to that in 1970, then type "1". If not, type "Ø".

DO YOU ASSUME STANDARD MORTALITY (1=YES, Ø=NO)?

If you assume that the mortality rates in your projections are the same as the 1970 figures, then type "1". If you think that mortality will be different, type "Ø". If you type "Ø", you will be allowed to change any or all of the mortality rates.

DO YOU ASSUME STANDARD POPULATION (1=YES, Ø=NO)?

Type "1" if you assume that the population at the start of your projection is equal to that in the 1970 census. If you type "Ø", you will be allowed to change any or all of the population groups.

When you have answered all of the above questions, the computer will be ready to make a projection of the population based on your assumptions. It will then ask:

REPORT: 1) SHORT 2) LONG 3) GRAPH 4) CHANGE ASSUMPTIONS 5) END?

If you select (1), you will receive a report similar to the one below. It gives year, total population and birth rate. It has the advantage of being fast.

YEAR 1970 POP. 204.8 MILLION FERTILITY 2.45

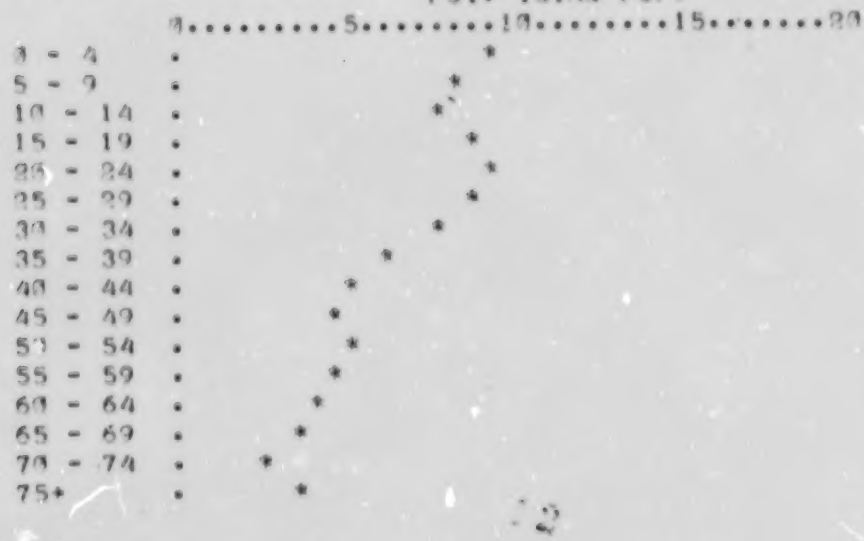
If you select (2), you will get all the information offered by (1), and in addition get a population breakdown by age and sex, similar to the report shown on the next page.

YEAR 1975 POP= 214.5 MILLION FERTILITY 2.45

AGES	FEMALES <-MILLIONS->	MALES	PCT. TOTAL
0 - 4	9.9	9.4	8.5
5 - 9	8.5	8.8	8
10 - 14	9.9	10.2	9.3
15 - 19	10.3	10.6	9.7
20 - 24	9.5	9.9	9
25 - 29	8.6	8.6	8
30 - 34	7	6.8	6.4
35 - 39	5.8	5.6	5.3
40 - 44	5.6	5.4	5.1
45 - 49	6	5.6	5.4
50 - 54	6.1	5.6	5.5
55 - 59	5.5	4.9	4.9
60 - 64	4.9	4.2	4.3
65 - 69	4.2	3.4	3.5
70 - 74	3.3	2.3	2.6
75 AND OVER	4.6	3.1	3.6

If you select (3), you will get all of (1), plus a graph showing age distribution in the population similiar to the following:

YEAR 1980 POP= 226.5 MILLION FERTILITY 2.45



Option (4) allows you to change any of your assumptions and then continue your projection; (5) allows you to end the projection.

You may have noticed that *USPOP* allows you to test a very large number of different assumptions about future population growth. For this reason it is very important to plan before going to the computer.

To aid in your planning, we have included EXPERIMENT PLAN SHEETS at the back of this Manual for planning your responses to the computer's questions.

IV. BASIC INVESTIGATIONS

INVESTIGATION #1 — *WHAT EFFECT WILL CHANGES IN FERTILITY HAVE ON POPULATION BY THE YEAR 2000?*

The year 2000 is less than 30 years away. If you study the table below, you will notice that fertility has varied greatly in the last 30 years. How might it change in the next 30?

Year	Fertility (children per female)
1940	2.3
1945	2.5
1950	3.1
1955	3.6
1960	3.7
1965	2.9
1970	2.45
1972	2.1 estimated

The 1970 census revealed a low of 2.45 children per female, and recently even lower figures have been estimated. Some demographers see this dip as permanent, while others say that this drop in fertility is only temporary, reflecting recent economic uncertainty.

Your objective, as the demographer, is to produce a set of assumptions that you think may hold for the next 30 years, and then to evaluate what effect change in fertility will have on the population in the year 2000.

USPOP allows you to control up to five factors at a single time. But in a controlled experiment we try to change only one variable at a time.

Suggested Procedure

1) Select from four to eight possible fertility figures (one should be equal to the 1970 fertility). Consult the table above for help in picking realistic values.

2) Record these fertility assumptions on an EXPERIMENT PLAN SHEET (found at the back of this Manual). Each fertility assumption should be entered for different projections.

3) Complete the remainder of the EXPERIMENT PLAN SHEET keeping all other factors uniform from projection to projection. (If you elect to use standard values, the computer program will automatically input 1970 figures for you.)

4) Run each of your projections separately up to the year 2000. The short report form (Report #1) will be satisfactory.

5) Construct either a table or a graph that summarizes your findings. If you use a graph, you can plot population on the y-axis versus years on the x-axis. To make the graph easier to read, use a different color for each of your projections.

6) Using your results, answer the follow-up questions.

Follow-up Questions

1) If fertility of women in the United States stays near the 1970 level of 2.45 children per female, how many additional people will there by by the year 2000?

2) New York City has a population of approximately 7 million people. How many New York-sized cities will have to be built to accommodate this increased population?

3) If fertility were to remain low (from 2 to 2.3), would the problem of extra population be as pressing? What in your results indicates this?

4) If fertility were to rise to levels seen in the middle fifties, approximately how many additional people could be expected by the year 2000 as compared to the current U. S. population?

5) What relationship exists between fertility and population growth?

INVESTIGATION #2

WHAT EFFECT WOULD DELAYING THE BIRTH OF THE FIRST CHILD HAVE ON POPULATION GROWTH?

As you should be able to see from the table below, the most likely time for a birth in a female's life is between the ages of 20 and 24. This is the time that most women have their first child. Of course, some women have their first child earlier and some later, and this too is indicated by the birth-distribution figures below:

Age	Per Cent of Total Fertility in 1970
10 - 14	.2
15 - 19	14.3
20 - 24	33.8
25 - 29	28.5
30 - 34	14.7
35 - 39	6.6
40 - 44	1,8
45 - 49	.1

Having the first child in the early twenties seems natural in the United States, but there are countries throughout the world where this would not be true. In countries such as India, large numbers of females marry in their early teens and have a child long before they are twenty. There are countries such as Ireland, where marriage has traditionally not taken place until the late twenties and therefore children are born later in life than here in the United States.

Would a change in birth distribution alter our population's growth rate? You, as a demographer, are assigned to investigate this question. You must test a series of assumptions using differing birth rates. You should compare our current distribution to distributions with the births occurring earlier and later.

Suggested Procedure

1) Using the EXPERIMENT PLAN SHEETS found at the end of this Manual, design from three to eight sets of inputs that differ only in their birth distribution. (One should be equal to the standard 1970 levels.) Notice that the sum of the percentages should always equal 100%.

2) Run each of your projections separately up to the year 2030. For this experiment the short report will be satisfactory.

3) Collect and organize your data. Graph population size versus years for each of your projections.

4) Answer the follow-up questions based on your results.

Follow-up Questions

1) If no change occurred in the birth distribution, what would be the expected population in the year 2030?

2) Do you feel that lowering the age at which most women have their first child would have much of an effect on the population? What in your data supports your view?

3) Would it be worthwhile for groups interested in population limitation to encourage women to have their children at a later age? Why?

4) Could having children at a younger age be related to any of the other variables such as fertility, mortality, sex ratio, etc.?*

5) Is there any general rule you can formulate to relate birth distribution and population growth? Is this rule shown in your graph?

*NOTE - *USPOP*'s model assumes that age distribution of mothers is not related to any other variable. This may not be realistic, however.

INVESTIGATION #3 — *WILL CHANGES IN INFANT MORTALITY AFFECT FUTURE POPULATION LEVELS?*

Infant mortality is embarrassingly high in the United States as compared with other advanced countries. As noted in the August 1971 issue of *SCIENTIFIC AMERICAN*, pg. 4, the United States ranks 14th among nations with regard to infant mortality.

Currently, the mortality rate for those less than one year old is about 22 deaths per 1000. If the United States decides to make a major effort to reduce infant mortality, what is a realistic goal? The article suggests that a rate of 17.4 deaths per 1000 may be the "minimum attainable mortality rate." This represents a reduction of 22%.

However, it may not prove possible to attain this low figure for all segments of the population. For this reason, as a demographer, you will want to produce a series of projections with varying assumptions.

NOTE: *USPOP* considers all children of less than 5 years as a single group. The mortality rate for the group, ages 0 to 4, is now 17.8 per 1000 for females and 22.4 per 1000 for males. We will assume, for this investigation, that if you change infant mortality, the mortality of the entire group is also changed by an equivalent amount.

Suggested Procedure

1) Use 1970 mortality rates as a comparison. In addition, select four to eight other changes in infant mortality.

2) Enter your different assumptions onto the EXPERIMENT PLAN SHEET found at the back of this Manual. Keep all other factors constant from projection to projection.

3) Run each projection separately up to the year 2020. Report #1 should be satisfactory, but for more information on births, select Report Form #2 (if time permits).

4) Organize your results. Below are some possible methods:

a) Make a table showing change in infant mortality and population in the year 2020.

b) Make a single graph showing population versus years. Each projection should be shown in a different color or pattern.(Make sure to include a key identifying each line.)

c) Make a graph showing population in the year 2020 versus change in infant mortality.

5) Answer follow-up questions.

Follow-up Questions

1) If a drop in infant mortality occurs, will it have a major impact on future population levels in the United States? What data do you have to support this conclusion?

2) Is the effect of lowering infant mortality more important or less important, as time goes on, in affecting total population size?

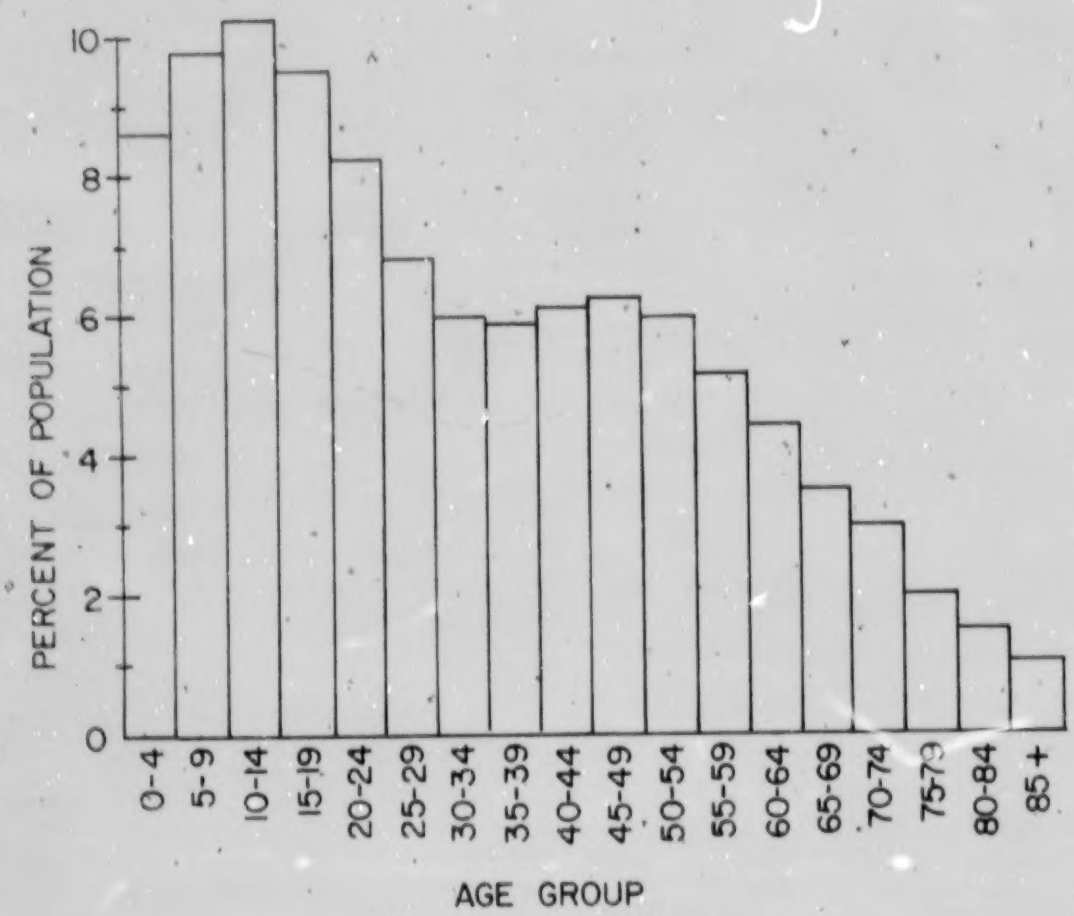
3) It has been said, "Those children who might have died due to high infant mortality now live long enough to have children of their own." Do you see any proof for this statement? If so, indicate what in your results backs up this statement; if not, indicate how your data shows this is not an important factor.

INVESTIGATION #4 — HOW DOES FERTILITY AFFECT THE AGE DISTRIBUTION OF THE POPULATION?

The median age in the United States today is about 28 years. This means that over half the population is younger than 30. In addition, approximately 34% of the population is under 18. Why do we have such a large proportion of young people in our population?

It seems obvious that both fertility and mortality should play an important role: if, for example, many people die in middle or old age, then a majority of those living should be young; if women have many children, then the children should outnumber the parents; in either case, the majority of the population should be young. In this experiment you will investigate the role fertility plays in determining the age distribution of the population. In Investigation #5, mortality will be investigated.

Our current population distribution is given on the graph below:



Suggested Procedure

You are investigating the effect fertility has on age distribution. To answer this question, you should design a set of inputs reflecting your assumptions:

1) Select from four to eight different, wide-ranging values for fertility. (1970 fertility was equal to 2.45 children per female.) Using an EXPERIMENT PLAN SHEET (found at the end of this Manual), write in a different fertility for each projection.

2) Complete the list of inputs for each projection, keeping all factors other than fertility constant.

3) Since we are investigating the effect of fertility on age distribution, you should select Report Form (2) or (3). Report Form (2) gives you age-distribution data in chart form, while Report Form (3) gives the age-distribution information in graphical form.

4) Run each of your projections to at least the year 2030. The longer you run your projections, the clearer the differences.

5) After carefully collecting your results, organize them into a more usable form, either chart or graph. Your teacher may instruct you as to which is preferred; if not, select the form you think best.

Follow-up Questions

1) From the results of your experiment, what effect would you say high fertility has on the age distribution of the population?

2) In countries with low fertility, would you expect to have more old people or fewer old people on a percentage basis? What in your data supports your opinion?

3) From your results, estimate a fertility that would result in an even age distribution throughout most of the population.

4) Give a possible reason why the 1970 U. S. age distribution shows a dip for those ages 30-39.

The chart below shows 5-year mortality rates determined in 1970 (number of deaths per 1000 over 5-year period).

Terminal Age Years	Male	Female
	Deaths per 1000	
0 - 4	22.5	17.8
5 - 9	3.5	2.8
10 - 14	2.2	1.5
15 - 19	4.9	2.2
20 - 24	9.6	3.4
25 - 29	10.5	4.0
30 - 34	10.3	5.2
35 - 39	12.9	7.4
40 - 44	19.0	11.1
45 - 49	29.3	16.7
50 - 54	45.1	25.8
55 - 59	69.1	35.8
60 - 64	106.9	51.4
65 - 69	156.5	78.9
70 - 74	220.7	121.4
75 and older	409.3	337.3

INVESTIGATION #5

EFFECT OF MORTALITY RATE ON AGE DISTRIBUTION IN THE POPULATION.

If you have not already done so, read the introduction to Investigation #4.

In this investigation, we will assume that the fertility remains constant and vary the mortality rates of the population to determine their effect on the age distribution.

There are many ways in which we might change mortality rates; for example, we might lower mortality for the young, or lower it for the old, or both. In this experiment we will assume that all ages will be affected evenly. If you want to investigate other possibilities, you should first speak to your instructor.

Suggested Procedure

You are to design an experiment in which you vary the mortality in order to evaluate the effect of different mortality rates on age distribution.

1) Select four to eight different sets of mortality rates. If you elect to use the standard rates as one of your sets, the computer will automatically input the 1970 mortality rates.

2) Enter each set of mortality figures into a different column on the EXPERIMENT PLAN SHEET (at the back of this Manual). For clearer results, select mortality rates that vary over a wide range.

3) Complete the rest of the sheet, keeping all other variables constant from projection to projection.

4) Select either Report Form (2) or (3), since they both give information on age distribution.

5) Run each of your projections for at least 50 years, or until you have clear results.

6) After completing all your projections, collect and organize your data into either a graph or table. If your teacher does not give you specific instructions, choose the form you think best.

Follow-up Questions

1)If there were a drastic increase in mortality in the future caused, say, by massive air pollution, would the age distribution be affected? If so, in what way?

2)If all ages had a lower mortality, which age group would show the greatest percentage increase? How do your results indicate this?

3)If current mortality conditions continued for the next 50 years, would the young (less than 30) still dominate the population?

4)If all mortality rates were to decrease substantially, what impact would that have on this country?

Further Investigation Suggestions

Investigate the role of sex ratio on both population number and age distribution.

Investigate possible reasons for the current U. S. age distribution.

See *USPOP RESOURCE MANUAL* for additional projects and ideas.

USPOP EXPERIMENT PLAN SHEET

NAME _____

INVESTIGATION _____

PROJECTION NUMBER	1	2	3	4	5	6	7	8
FERTILITY 1=STANDARD (1970) Ø=CHANGED								
IF ABOVE IS Ø NEW FERTILITY (CHILDREN PER FEMALE)								
WILL FERTILITY 1=STAY CONSTANT 2=CHANGE TO NEW FIGURE								
BIRTH DISTRIBUTION 1=STANDARD Ø=CHANGED								
IF ABOVE IS Ø % FERTILITY IN 10 - 14								
15 - 19								
20 - 24								
25 - 29								
30 - 34								
35 - 39								
40 - 44								
45 & older								
TOTAL MUST EQUAL 100								
SEX RATIO 1=STANDARD (1970) Ø=CHANGED								
IF ANSWER ABOVE Ø % FEMALE BIRTHS								

PROJECTION NUMBER	1		2		3		4		5		6		7		8	
MORTALITY 1=STANDARD (1970) Ø=CHANGED																
IF ANSWER Ø DEATHS PER 1000	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
IN AGES: 0 - 4																
5 - 9																
10 - 14																
15 - 19																
20 - 24																
25 - 29																
30 - 34																
35 - 39																
40 - 44																
45 - 49																
50 - 54																
55 - 59																
60 - 64																
65 - 69																
70 - 74																
75 & older																
POPULATION 1=STANDARD (1970) Ø=CHANGED*																

REPORT:
1=SHORT REPORT
2=LONG REPORT
3=AGE DISTRIBUTION GRAPH
4=CHANGE ASSUMPTIONS
5=END

THIS QUESTION WILL BE REPEATED THROUGHOUT RUN

*If population changed, use chart similar to that in mortality section.

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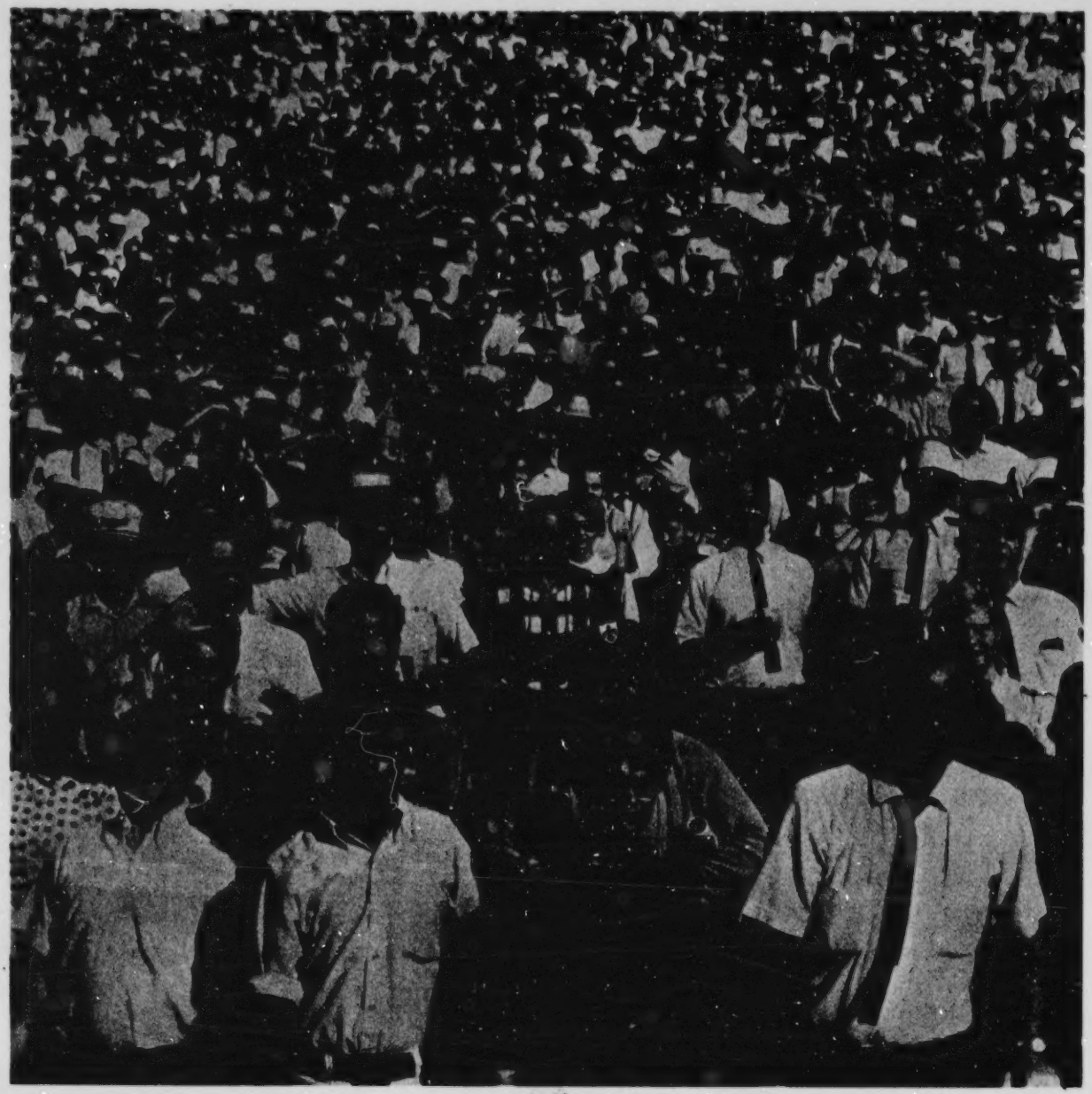

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TEACHER
MANUAL

USPOP

UNITED STATES POPULATION STUDY

Developed By:

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HUNTINGTON TWO COMPUTER PROJECT

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13 June 1973

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USPOP

TEACHER MANUAL

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USPOP

TEACHER MANUAL

I. BASIC INFORMATION ABOUT THE UNIT

Subject Area: Biology, Ecology, Social Studies

Specific Topic: Human Population Projection (USA)

Grade Level: 10 - 12

Coordinated Computer Program: *USPOP*

Computer Language: BASIC

Special Language Features Used: TAB

Abstract: *USPOP* is a highly flexible human population model. In order to make student use easier, the model has been oriented towards investigation of United States population projections. Other applications are covered in the accompanying *RESOURCE MANUAL*.

The student can investigate the effects of fertility, age of mother at birth of child, sex ratio of the offspring and age-dependent mortality on population size and structure. Through use of 1970 census data, held in DATA statements, the student need enter only a few of the required inputs.

If the student or teacher wishes to model situations other than that collected in the DATA statements, all or some of the required inputs may have to be changed.

II. INTRODUCTION TO THE *USPOP* UNIT

Students are deeply concerned with the effect of population growth, but they often lack a solid body of information on which to base a solution. Lack of information often leads to a sense of frustration and hopelessness.

USPOP uses simulation techniques as a stimulus to learning in the teaching of many key demographic concepts involving population growth and age distribution. Students play the role of demographers projecting future population trends. The *STUDENT MANUAL* leads the student through a series of five investigations, each involving a single concept. The following concepts are explored:

INVESTIGATION #1. Effect of fertility on population growth. Fertility is seen to have a major impact on population growth.

INVESTIGATION #2. Effect of time of birth of first child on the population-growth rate. Surprisingly, delaying the birth of the first child can slow population growth, even if the total number of offspring remains constant.

INVESTIGATION #3. Effect of reducing infant mortality. Reducing infant mortality to the lowest level realistically possible is seen to have only a minor impact on future population size.

INVESTIGATIONS #4 and #5. Exploration of factors affecting age distribution in a population. Again fertility is seen as the major factor. Mortality is important, but it has only a secondary effect on age distribution in the population.

III. USING *USPOP* WITH YOUR CLASS

A. Using *USPOP* as a Student Laboratory

We hope that this will be your primary use of *USPOP*. As different teachers have access to different facilities, we have subdivided this section according to teletype availability.

NOTE: *USPOP* is based on the latest information available at the time of publication. Instructions have been included in the *RESOURCE MANUAL* for updating *USPOP* as newer data becomes available. (See Section IV, Part F.)

1) For those teachers having access to multiple-user systems or those having their students working on their own time:

In cases where whole classes are using *USPOP*, we suggest that you have different groups of students run each of the five student investigations, prepare separate reports and then report back to the group as a whole. After this, you may wish to carry out some of the more sophisticated investigations found in the *RESOURCE MANUAL*.

2) For those teachers with access to a single teletype only:

The great flexibility of *USPOP* presents a problem. Each single investigation requires approxmiately 45 minutes for a single group of students. As a result, for a given double laboratory period, a maximum of from 6 to 8 students (working in teams of 3 or 4) can make use of the computer. Below are two alternative suggestions, from teachers in a similar teaching situation, that have proven successful:

a) Rotate your class through the *USPOP* investigations. While one or two groups are working on *USPOP*, the other students can be carrying out related traditional laboratory exercises; in succeeding weeks let the other students use the computer. *USPOP* materials have been written in such a way so as to encourage students to investigate independently.

b) Have the entire class explore a single *USPOP* student investigation, but divide the labor. Since each investigation is written in such a way as to require from 4 to 8 trial runs before a conclusion can be reached, you might have each team of students make one or two trial runs and prepare a report of results for the entire class. This approach can be even more instructive than the individual approach, depending on the teacher's planning and preparation of such tasks as organizing each group's role, preparation of appropriate summary tables for the collection of data, and class preparation for the students' roles as demographers working as a team to solve a complex problem in a minimum amount of time.

B. Using *USPOP* for Project Work or Individualized Instruction

Most students should be encouraged to work with one or more of the investigations in the *STUDENT MANUAL* before attempting more sophisticated studies. In the accompanying *RESOURCE MANUAL*, there are several advanced investigations designed as open-ended experiments for the individual student.

Some students will want to use *USPOP* on their own. In this case, it is suggested that the student be given the background materials in the *RESOURCE MANUAL* as a source of ideas for alternative investigations. In addition, the student *must* be aware of the *USPOP* model assumptions, also found within the *RESOURCE MANUAL*.

C. *USPOP* as a Classroom Tool

While designed as a laboratory simulation, *USPOP* may also be useful to the teacher who neither has the time nor the computer facilities for individual or group use of the program. Below are concepts that the teacher might want to explore with an entire class by using *USPOP*.

1) Population forecasting. Have your students read the background materials in the *STUDENT MANUAL* and ask them to predict changes in fertility, birth distribution, sex ratio of offspring, and mortality (especially infant and old age). Prior to using *USPOP* in class, discuss their decisions, and when agreement has been reached, use *USPOP* to make the resultant projection. Remember, it is wise to compare their projection with a control. A good comparison might be conditions in the future, should the 1970 conditions remain constant.

2) Zero population growth (ZPG). There are several interesting (and surprising) aspects to this subject. You may want to explore the following questions in some detail: a) Will ZPG occur if fertility falls to 2 children per family, and b) What changes might result in ZPG immediately? For a general approach to this problem, see the ADDITIONAL STUDENT PROJECTS Section in the *RESOURCE MANUAL*.

NOTE: Due to *USPOP*'s extreme flexibility, teachers may accidentally violate one of *USPOP*'s model assumptions. For this reason, you are encouraged to first try any original exercise outside of class. A list of model requirements can be found in the *RESOURCE MANUAL*.

IV. SAMPLE RUNS

The runs below can be used to check the performance of *USPOP* once it is loaded in your computer.

SAMPLE RUN #1 illustrates the many variations possible with *USPOP*. Explanation of student responses are enclosed in boxes.

RUN #1

```
DO YOU WANT REPORTS 1) EVERY 5 YEAR INTERVAL
OR 2) SELECTED YEARS ?1

YEAR AT START OF PROJECTION ?1970

DO YOU ASSUME STANDARD FERTILITY (1=YES,0=NO) ?1
WILL FERTILITY (1) STAY AT 2.45  OR (2) CHANGE SLOWLY
TO A NEW LEVEL ?1

DO YOU ASSUME STANDARD BIRTH DISTRIBUTION (1=YES,0=NO) ?1

DO YOU ASSUME STANDARD SEX RATIO (1=YES,0=NO) ?1

DO YOU ASSUME STANDARD MORTALITY (1=YES,0=NO) ?1

DO YOU ASSUME STANDARD POPULATION (1=YES,0=NO) ?1
```

IF THE STUDENT ANSWERS ANY OF THESE QUESTIONS WITH "1" (YES), THEN THE COMPUTER WILL READ IN 1970 DATA STORED WITHIN THE PROGRAM.

STUDENT HAS SELECTED THE LONG REPORT.

```
REPORT:1)SHORT 2)LONG 3)GRAPH 4)CHANGE ASSUMPTIONS 5)END ?2
```

```
YEAR 1970      POP=  204.8  MILLION          FERTILITY 2.45
 AGES     FEMALES <-MILLIONS-> MALES          PCT. TOTAL
 0 - 4          8.4              8.7              8.3
 5 - 9          9.7              10.1             9.7
 10 - 14        10.2             10.5             10.1
 15 - 19        9.4              9.7              9.4
 20 - 24        8.5              8.6              8.3
 25 - 29        6.9              6.8              6.7
 30 - 34        5.8              5.6              5.6
 35 - 39        5.7              5.5              5.4
 40 - 44        6.1              5.8              5.8
 45 - 49        6.2              5.9              5.9
 50 - 54        5.7              5.3              5.3
 55 - 59        5.2              4.7              4.8
 60 - 64        4.6              4                4.2
 65 - 69        3.7              3                3.3
 70 - 74        3.2              2.3              2.7
 75 AND OVER    4.6              2.9              3.7
```

IT GIVES POPULATION IN THOUSANDS FOR EACH COHORT AND THE AGE DISTRIBUTION IN THE POPULATION.

```
REPORT: ?4

WHAT DO YOU WANT TO CHANGE?
1-FERTILITY, 2-BIRTH DISTRIBUTION, 3-SEX RATIO
4-MORTALITY, 5- POPULATION ?4


CHANGE IN MORTALITY OCCURING IN FEMALES
GROUPS (FROM AGE, TO AGE) ?65,90
GROUP          CURRENT          NEW VALUE
               DEATH/1000
 65 - 69         78.9             ?66
 70 - 74        121.4             ?102
75 AND OVER     337.3             ?300


CHANGE IN MORTALITY OCCURING IN MALES
GROUPS (FROM AGE, TO AGE) ?0,0

REPORT: ?1

YEAR 1975     POP=  214.9  MILLION        FERTILITY 2.45

REPORT: ?3

YEAR 1980     POP=  227.2  MILLION        FERTILITY 2.45
                        PCT. TOTAL POP.
          0.........5.........10.........15.......20
 0 - 4    .                    *
 5 - 9    .                  *
 10 - 14  .                 *
 15 - 19  .                   *
 20 - 24  .                    *
 25 - 29  .                   *
 30 - 34  .                 *
 35 - 39  .              *
 40 - 44  .           *
 45 - 49  .          *
 50 - 54  .           *
 55 - 59  .          *
 60 - 64  .         *
 65 - 69  .       *
 70 - 74  .     *
 75+      .       *
```

BY TYPING 4, THE STUDENT IS ALLOWED TO ALTER AN ASSUMPTION AND THEN RESUME THE PROJECTION.

THIS ANSWER MEANS THAT THE STUDENT WISHES TO ALTER THE MORTALITY RATES FOR FEMALES BETWEEN THE AGES OF 65 AND 90. THE COMMA BETWEEN THE TWO NUMBERS IS IMPORTANT.

BY TYPING 0,0 THE STUDENT HAS INDICATED HE WISHES TO MAKE NO CHANGE IN MALE MORTALITY RATES.

REPORT 3 PRESENTS THE AGE STRUCTURE OF THE POPULATION IN GRAPHICAL FORM.

SAMPLE RUN #2 illustrates the use of selected year reports. By answering the first question with response "2", the student is able to skip reports and investigate a longer period of time more quickly.

RUN #2

```
DO YOU WANT REPORTS 1) EVERY 5 YEAR INTERVAL
OR 2) SELECTED YEARS ?2

YEAR AT START OF PROJECTION ?1970

DO YOU ASSUME STANDARD FERTILITY (1=YES,0=NO) ?0
FERTILITY IN 1970  ?2.4
WILL FERTILITY (1) STAY AT 2.4  OR (2) CHANGE SLOWLY
TO A NEW LEVEL ?2
WHAT FERTILITY WILL BE STABLE ?2.06
HOW MANY DECADES UNTIL FERTILITY REACHES 2.06  ?3

DO YOU ASSUME STANDARD BIRTH DISTRIBUTION (1=YES,0=NO) ?1

DO YOU ASSUME STANDARD SEX RATIO (1=YES,0=NO) ?1

DO YOU ASSUME STANDARD MORTALITY (1=YES,0=NO) ?1

DO YOU ASSUME STANDARD POPULATION (1=YES,0=NO) ?1

REPORT:1)SHORT 2)LONG 3)GRAPH 4)CHANGE ASSUMPTIONS 5)END ?1

YEAR 1970      POP=  204.8  MILLION          FERTILITY 2.4
YEAR FOR NEXT REPORT ?2000

REPORT: ?3

YEAR 2000      POP=  264.2  MILLION          FERTILITY 2.06
                          PCT. TOTAL POP.
          0.........5.........10.........15.......20
 0 - 4    .                *
 5 - 9    .                *
 10 - 14  .                 *
 15 - 19  .                 *
 20 - 24  .                *
 25 - 29  .               *
 30 - 34  .              *
 35 - 39  .                *
 40 - 44  .                *
 45 - 49  .               *
 50 - 54  .            *
 55 - 59  .         *
 60 - 64  .       *
 65 - 69  .      *
 70 - 74  .    *
 75+      .      *
YEAR FOR NEXT REPORT ?2033

REPORT: ?5

ANOTHER PROJECTION (1=YES, 0=NO) ?0
```

V. KEY TO STUDENT LABORATORY INVESTIGATIONS

INVESTIGATION #1 — *WHAT EFFECT WILL CHANGES IN FERTILITY HAVE ON POPULATION BY THE YEAR 2000?*

This is a rather easy exercise. Intuitively, the student will hypothesize that increased fertility will increase the population in the year 2000. To make this investigation more meaningful, ask your students (before they start to calculate) their age in the year 2000 and the number of children they want in their future families. (This last number equals fertility.)

While many students will be able to hypothesize the results, they may be surprised at the large difference in population that would result if fertility climbed back to its 1960 levels.

Additional Student Instructions

Students should pick at least four values for fertility (values between 2 and 4); all other factors should remain constant from projection to projection. To speed student use of the computer, encourage each student to:

1) use standard (1970) values for birth distribution, sex ratio, mortality and population. These can be supplied by the computer program if the student responds to a question such as:

   DO YOU ASSUME STANDARD SEX RATIO (1=YES, Ø=NO)?

   by typing the number 1.

2) select the short report on population. This is done by typing the number 1 in response to:

   REPORT?

To make it possible for a large number of students to use the computer in a very short time, *USPOP* allows the student to skip all the years between 1970 and 2000 before obtaining a report; this can be done by asking for reports only on selected years. For smaller groups, it is suggested that you encourage students to get reports every 5 years. (See Sample Runs for illustrations.)

After running each projection, students should organize their resulting data in a useful way, e.g., graphical techniques which give clear results. The sample results following illustrate two possible graphing techniques.

Sample Results

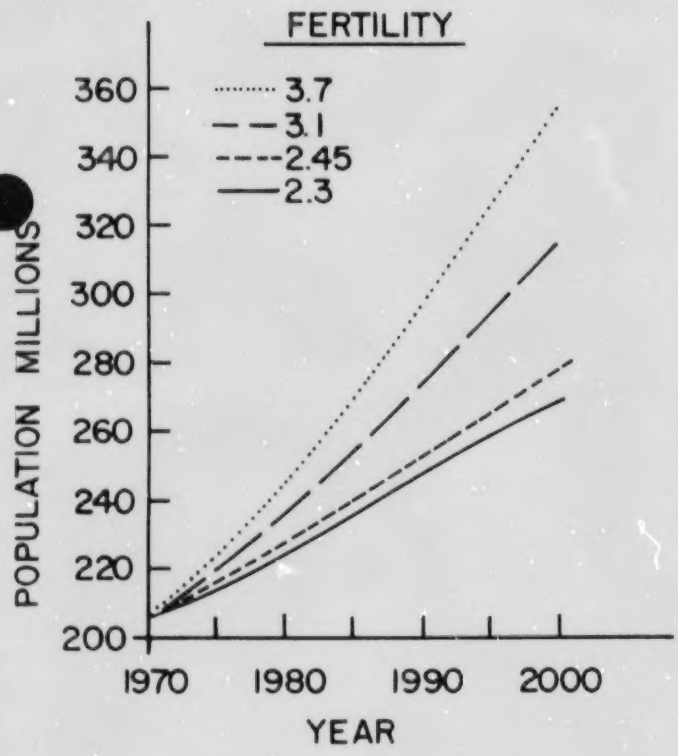
These results were obtained using the following fertilities (children/ women's completed family):

2.3
2.45 (control)
3.1
3.7

Your student's results will vary with the particular values he selects to investigate.

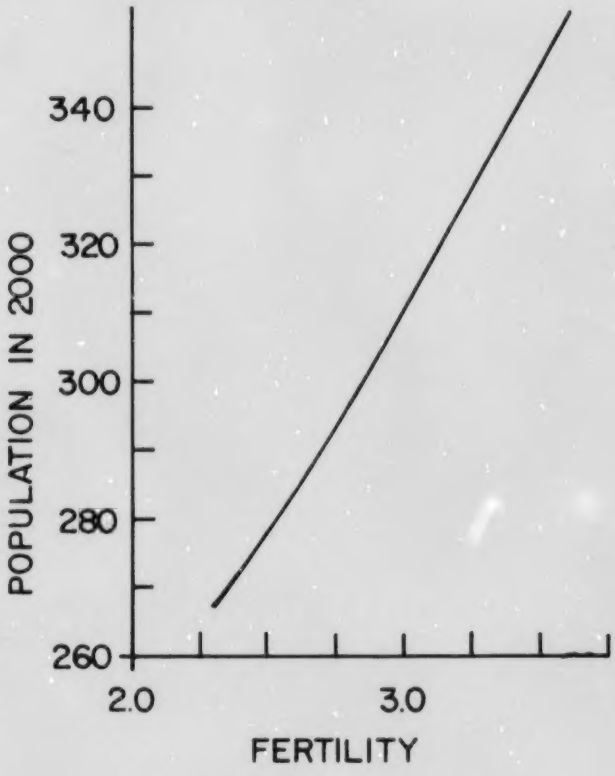
SOLUTION TECHNIQUE #1

POPULATION vs. TIME



SOLUTION TECHNIQUE #2

POPULATION IN YEAR 2000
vs.
FERTILITY



Both of these graphs indicate the clear effect that fertility has on population growth. This is the reason that underdeveloped countries with population problems attempt first to control fertility.

Sample Answers to Student Follow-up Questions - These are only sample answers. Actual answers will vary with the fertilities that your students have elected to study.

1) *IF FERTILITY OF WOMEN IN THE UNITED STATES STAYS NEAR THE 1970 LEVEL OF 2.45 CHILDREN PER FEMALE, HOW MANY ADDITIONAL PEOPLE WILL THERE BE IN THE YEAR 2000?*

Approximately 70 million people, assuming that all other factors remain constant at 1970 levels.

2) *NEW YORK CITY HAS A POPULATION OF APPROXIMATELY 7 MILLION PEOPLE. HOW MANY NEW YORK-SIZED CITIES WOULD HAVE TO BE BUILT TO ACCOMMODATE THIS INCREASED POPULATION?*

About 10 large cities would be required if fertility remains at 1970 levels. A more likely outcome might be a further increase in the size of small and medium-sized communities. This natural increase of the population coupled with the flow to the city of the rural population has caused great concern on the part of urban planners.

3) *IF FERTILITY WERE TO REMAIN LOW (FROM 2 TO 2.3), WOULD THE PROBLEM OF EXTRA POPULATION BE AS PRESSING? WHAT IN YOUR RESULTS INDICATES THIS?*

If fertility were to fall to 2.3, we could expect about 10 million fewer people in the year 2000 than was projected above; this is a drop of about 15%. Should fertility drop still lower, even greater differences will result.

4) *IF FERTILITY WERE TO RISE TO LEVELS SEEN IN THE MID-FIFTIES, APPROXIMATELY HOW MANY ADDITIONAL PEOPLE COULD BE EXPECTED BY THE YEAR 2000 AS COMPARED TO THE CURRENT U. S. POPULATION?*

If fertility should return to about 3.7 children per completed family, we would expect an increase of 140 million people by the year 2000. This represents an increase of approximately 65%.

5) *WHAT RELATIONSHIP EXISTS BETWEEN FERTILITY AND POPULATION GROWTH?*

Fertility has a direct effect on population growth. The greater the fertility, the greater the growth, and vice versa.

Additional Discussion Questions

- How many children does the average female student want for her family? the average male?
- Will more or fewer women in the future raise families? What will be the effect on fertility in either case?
- Has information on television and in print affected the student attitude toward family size?
- What would happen if the fertility fell below 2.0?

  (Use *USPOP* in class to solve this one. YOU AND YOUR STUDENTS MAY BE SURPRISED.)
- How does *USPOP* help to plan for future ecology programs, the energy crisis, and so forth?

INVESTIGATION #2 — *WHAT EFFECT WOULD DELAYING THE BIRTH OF THE FIRST CHILD HAVE ON POPULATION GROWTH?*

We have found that most individuals feel that the time of birth should have no effect on the rate of population growth. This is not the case. While the effect is small at first, it is real, and over long periods of time the delaying of births can have a significant effect.

It should be pointed out that the number of births to a female is exactly the same in all the cases investigated in this experiment. If a student should doubt this, have him investigate it for himself by asking for the long form of the printout.

Because the results are not intuitive and there are many possible birth patterns, this investigation is more difficult than *INVESTIGATION #1;* but a student attempting to arrive at an original solution will almost always produce gratifying results.

Additional Student Instructions

These are provided so you might help those students having trouble setting up their investigation.

Only birth distribution should vary from run to run. If you have your students use the EXPERIMENT PLAN SHEETS provided in the *STUDENT MANUAL*, it should be easy to check whether all other variables are being held constant. (It will be easiest for the student to set these other variables to 1970 values.)

Any birth distribution can be investigated. The only restriction is that the numbers for all the fertile ages should sum to 100. (Numbers should be entered as percentages, not decimal fractions of 1.) Generally, it is best for the student to select distributions that show a clear effect: either few births in the early years or few births in the later years. REMEMBER, one of the runs should use the current 1970 birth distribution!

Runs will be quicker if students select report form 1, but all these reports will give satisfactory data.

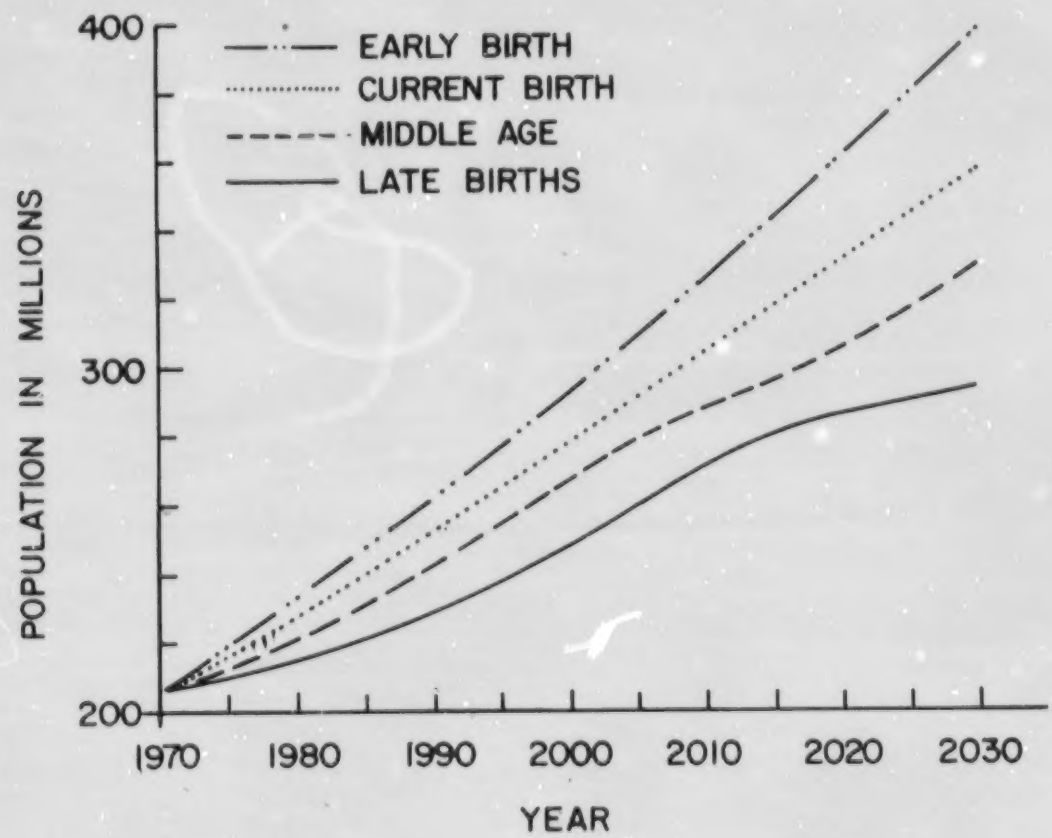
The *STUDENT MANUAL* suggests to the student that he graph the results of each of his runs. You may instruct him as to the format. We feel that putting all runs on a single graph with use of different colors will make interpretation easier. (See sample results following.)

Sample Results

Actual results will differ according to the sets of assumptions that each student chooses to investigate, but the patterns should be similar. Consider, for example, the following sets of assumptions:

TRIAL AGES	1	2	3	4
10-14	c(.2)	33.2	.0	.0
15-19	o(14.3)	33.4	.1	.1
20-24	n(33.8)	33.0	.1	.1
25-29	t(28.5)	.1	33.0	.1
30-34	r(14.7)	.1	33.2	.1
35-39	o(6.6)	.1	33.4	33.0
40-44	1(1.8)	.1	.1	33.4
45+	(.1)	.0	.1	33.2

The resulting graph of POPULATION vs. TIME for each of these birth distributions is given below:



Sample Answers to Student Follow-up Questions

1) *IF NO CHANGE OCCURRED IN BIRTH DISTRIBUTION, WHAT WOULD BE THE EXPECTED POPULATION IN THE YEAR 2030?*

Nearly 360 million people, assuming that all variables remained near 1970 values.

2) *DO YOU FEEL THAT LOWERING THE AGE AT WHICH MOST WOMEN HAVE THEIR FIRST CHILD WOULD HAVE MUCH OF AN EFFECT ON THE SIZE OF THE POPULATION? WHAT IN YOUR DATA SUPPORTS YOUR VIEW?*

Earlier births, especially in the teens, exert a large force for growth in an expanding population by an additional 40 million over what would normally be expected in the year 2030, if 1970 conditions were maintained.

3) *WOULD IT BE WORTHWHILE FOR GROUPS INTERESTED IN POPULATION LIMITATION TO ENCOURAGE WOMEN TO HAVE CHILDREN AT A LATER AGE? WHY?*

This is a matter of opinion. There are those in family planning who maintain that the only effective action is to reduce fertility; others point to examples such as Ireland where later births have been at least partially effective in controlling the rate of growth.

4) *COULD HAVING CHILDREN AT A YOUNGER AGE BE RELATED TO ANY OF THE OTHER VARIABLES SUCH AS FERTILITY, MORTALITY, SEX RATIO, ETC.?*

In general, it would seem likely that having children at a younger age would lead to increased fertility. Also, since younger mothers tend to have more boys than older mothers, this might lead to a changed sex ratio. In India, where many women become pregnant in their early teens, there is some indication that early birth is related to increased female and infant mortality.

The practice of having children at an older age might lead to opposite effects.

5) *IS THERE ANY GENERAL RULE THAT YOU CAN FORMULATE TO RELATE BIRTH DISTRIBUTION AND POPULATION GROWTH? IS THIS RULE SHOWN IN YOUR GRAPH?*

For a growing population, the later the children are produced in the mother's life, the lower the rate of population growth.

As a follow-up in class, explore the effect of all children being born to a single age group. Although this is an unrealistic assumption, it will produce a clearer picture of the birth distribution effect.

INVESTIGATION #3 — *WILL CHANGES IN INFANT MORTALITY AFFECT FUTURE POPULATION LEVELS?*

To carry out this investigation, the student must be able to vary infant mortality. Since we view the population in 5-year age groupings (cohorts), the student must adjust the interval 0 to 4 for both the males and the females. This is a more complicated task than is required for either of the previous investigations. If the student encounters trouble, consult the more detailed operating instructions given below.

Our infant mortality rate, while a national disgrace, does not currently depress the national population growth rate to any great extent. If altered within the feasible range of change (see *Scientific American* article, Aug. '71, p. 45) slight changes might be detectable by the year 2020.

Should your students be concerned that they are not getting results, you may wish to reassure them that not all experiments *seem* to show the anticipated result. No change *is* a result.

Additional Student Instructions

The student is asked to make from four to eight experimental runs using different mortality rates. All other factors should remain the same from run to run. If you have had the students make use of the EXPERIMENT PLAN SHEETS found at the back of the *STUDENT MANUAL*, you should be able to detect improper experimental design.

In order to vary the mortality for infants, the student must answer the question "STANDARD MORTALITY?" with a "Ø", representing NO. The computer program will then ask what female age groups the student wants to vary. A proper response would be "Ø,4" (from birth Ø to age 4). The computer will give the student the old mortality rate in deaths per 1000 and ask for a new rate. Any number from Ø to 1ØØØ can be typed. For this investigation it has been suggested that the lowest possible mortality rate is near 17.5, but allow the student to choose any rate he feels possible. After changing the female infant mortality, the male mortality should be similarly adjusted.

Students may be encouraged to use Report Form 1 if speed is important, but Report Form 2 (long report) is desirable for this exercise, since the student can see the effect of infant mortality on those just born.

The *STUDENT MANUAL* indicates three possible ways in which the data might be organized. It would be best to ask the students to try all three as a homework assignment. (See Sample Results following for the two graphical techniques.)

Sample Results

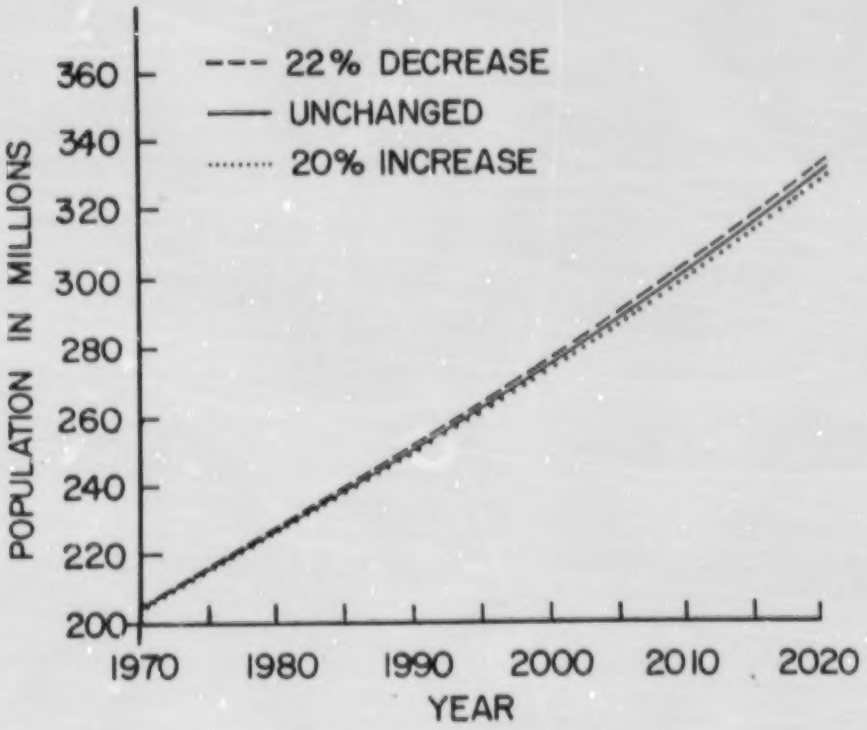
Each student's results will vary from those shown here depending on the particular mortality changes the student elects to investigate. A student may choose to investigate the following situations:

1) conditions of 1970 continuing

2) decreased infant mortality of 22%

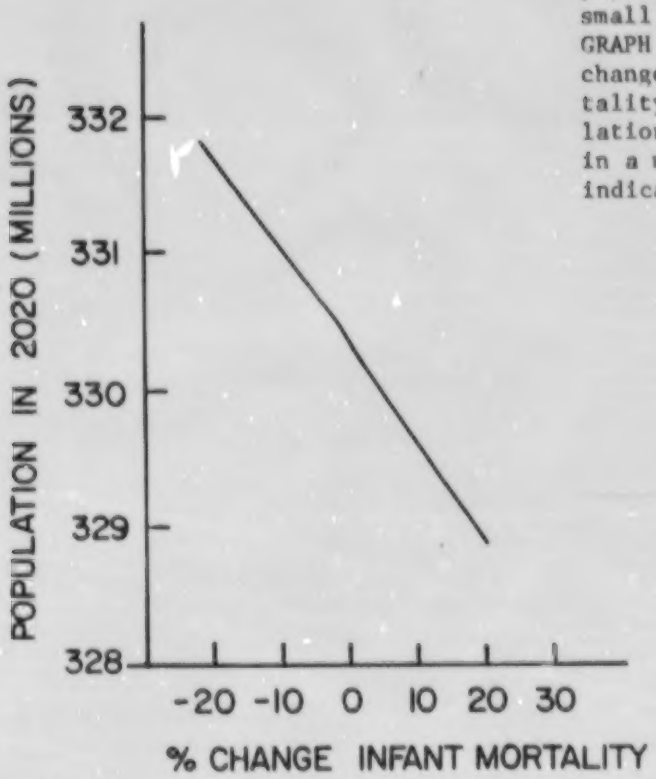
3) increased infant mortality of 20%

Results of these runs were organized into two different graphical formats. GRAPH 1 shows population size versus year; GRAPH 2 displays population in the year 2020 versus per cent change in infant mortality.



GRAPH 1

The absolute effects of 3 different infant mortality rates on population size are small as indicated by GRAPH 1; however, changes in infant mortality do affect population size, if only in a minor way, as indicated in GRAPH 2.



GRAPH 2

Sample Answers to Student Follow-up Questions

1) *IF A DROP IN INFANT MORTALITY OCCURS, WILL IT HAVE A MAJOR IMPACT ON FUTURE POPULATION LEVELS IN THE UNITED STATES? WHAT DATA DO YOU HAVE TO SUPPORT THIS CONCLUSION?*

The impact of infant mortality changes *that are likely* should prove to be very small. GRAPH 1 indicates the effect.

2) *IS THE EFFECT OF LOWERING INFANT MORTALITY MORE IMPORTANT OR LESS IMPORTANT AS TIME GOES ON IN AFFECTING TOTAL POPULATION SIZE?*

As indicated by GRAPH 1, the difference grows with time.

3) *IT HAS BEEN SAID: "THOSE CHILDREN WHO MIGHT HAVE DIED DUE TO HIGH INFANT MORTALITY NOW LIVE LONG ENOUGH TO HAVE CHILDREN OF THEIR OWN." DO YOU FIND ANY PROOF FOR THIS STATEMENT? IF SO, INDICATE WHAT IN YOUR RESULTS BACKS UP THIS STATEMENT; IF NOT, INDICATE HOW YOUR DATA SHOWS THIS IS NOT AN IMPORTANT FACTOR.*

This is a matter of interpretation. If the student has collected data using Report Form 2 or 3, he may have a positive indication. Have the class look at such data and interpret it as a group.

Additional Suggestion

We have restricted the students to investigating likely changes; but unlikely changes are not impossible. Check the results of doubling infant mortality, halving it, or even greater changes.

INVESTIGATION #4 — *HOW DOES FERTILITY AFFECT THE AGE DISTRIBUTION OF THE POPULATION?*

Up to this point the student has been investigating population growth. We are now investigating something about the make-up of the population. The size of the population in the next two investigations is relatively unimportant.

Most demographers feel that the fertility rate of a population is the prime determinant of age structure within a stable population.

Before starting the student on this investigation, discuss the age structure of the United States population and possible reasons why there are so many more young people than old. (A graph of U. S. age distribution is shown in the *STUDENT MANUAL* under Investigation #4.) An alternative approach is to have your students canvass their area to determine the age structure of the area.

Additional Student Instructions

These are included so that you might guide students who are unable to resolve the problems involved in designing a meaningful experiment.

As fertility is the single variable that we wish to explore, it alone should be varied from run to run; all other variables should remain fixed. It will be easiest for the student if he maintains 1970 values for these other variables.

For optimum results, the students should be encouraged to select a wide range of fertilities, from 0.0 to at least 10. Report form 3 (or 2) should be selected, since both these forms give results in terms of age distribution.

The manner in which this data is organized is left up to each individual. For those having trouble, these suggestions might prove useful:

1) Superimpose the graphs of age distribution for a certain year (e.g., year 2030).

2) Approximate median age at a certain year for all your runs and organize a table showing the relationship of fertility and median age.*

3) Organize the graphs of age distribution for a certain year, so that they are side by side for easy comparison.

---

*Median age can be approximated by cutting along both axes of the graph and then along the line connecting the points. Hold the cut-out over a ruler edge that is in the direction of the y-axis (i.e., Per Cent of Population axis). Move the graph back and forth over the ruler until it is balanced. The intercept of the ruler and the x-axis marks the approximate median age.

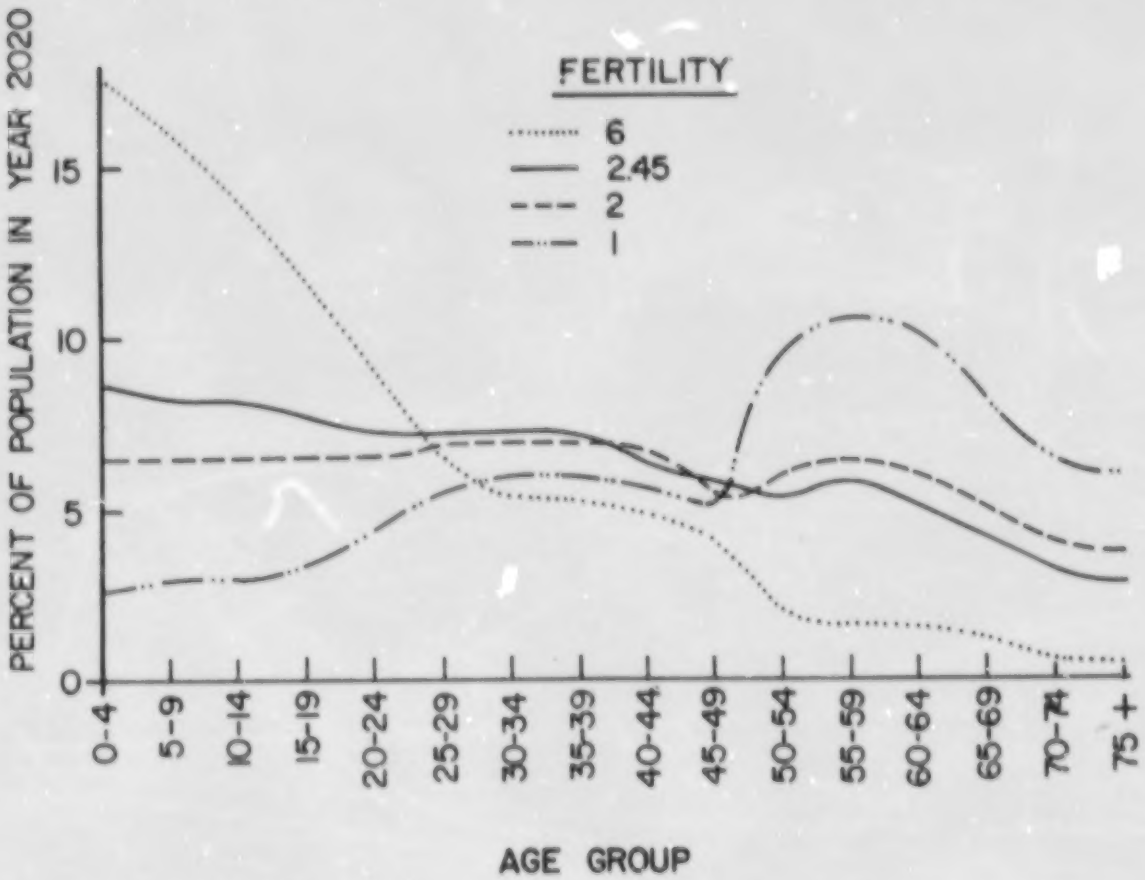
Sample Results

Your students' results will vary with the particular fertilities that they choose to work on. For example, let's assume that certain students chose to investigate the following fertilities:

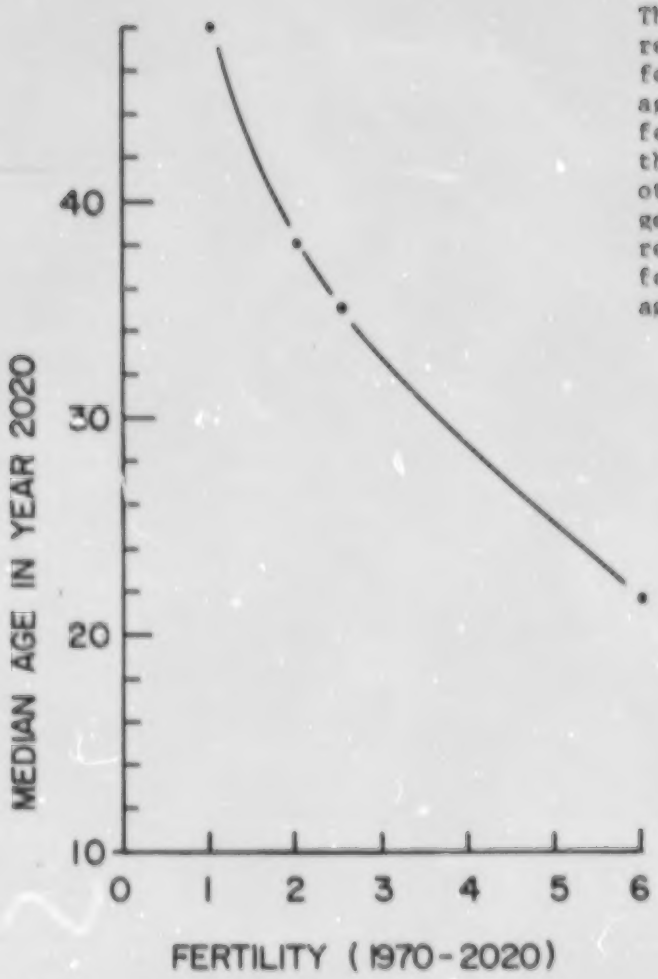
Trial 1 - 2.45 (control)
Trial 2 - 6
Trial 3 - 2
Trial 4 - 1

Each trial was run to the year 2020. Run the trial for a longer period of time if possible, since the longer the trial is run the clearer the results, those born before the institution of the new fertility rate being eliminated from the population.

Results of age distribution in the population were determined in two ways: 1) graph of population in the year 2020 versus age group, and 2) graph of median age versus fertility.



The above graph indicates a general pattern in a population with a high fertility: the younger ages are dominant. In populations with low fertilities, there is generally either an even distribution or an old-age dominant distribution.



This graph shows the relationship between fertility and median age. The higher the fertility, the lower the median age. In other words, there is generally an inverse relationship between fertility and median age of a population.

Sample Answers to Student Follow-up Questions

These are only examples of proper responses. Exact, correct responses will be determined by the particular fertilities the student has chosen to investigate.

1) *FROM THE RESULTS OF YOUR EXPERIMENT, WHAT EFFECT WOULD YOU SAY HIGH FERTILITY HAS ON THE AGE DISTRIBUTION OF THE POPULATION?*

High fertility causes the age distribution to show a larger percentage of people in the younger age classes.

2) *IN COUNTRIES WITH LOW FERTILITY, WOULD YOU EXPECT TO HAVE MORE OLD PEOPLE OR FEWER OLD PEOPLE ON A PERCENTAGE BASIS? WHAT IN YOUR DATA SUPPORTS YOUR OPINION?*

With a lower fertility, the population should show more old people. The data indicates that with low fertility, the population tends to be more balanced, whereas the United States with a high fertility shows an age distribution that has many more young people.

3) *FROM YOUR RESULTS, ESTIMATE A FERTILITY THAT WOULD RESULT IN AN EVEN AGE DISTRIBUTION THROUGHOUT MOST OF THE POPULATION.*

In general a fertility close to 2.0 will result in a very even age distribution, if the fertility and all other factors remain constant over a long period of time.

4) *GIVE A POSSIBLE REASON WHY THE 1970 U.S. AGE DISTRIBUTION SHOWS A DIP FOR THOSE AGES 30-39.*

The age distribution graph, found in the *STUDENT MANUAL* for Investigation #4, shows that the percentage of people of ages 30-39 is lower than that of those immediately younger or older. It is hoped that the students will realize that a temporary drop in fertility 30 to 40 years ago might have resulted in this drop. This period roughly corresponds to the time of World War II and the Great Depression. (For exact fertility figures, see the *RESOURCE MANUAL*.)

INVESTIGATION #5 — *EFFECT OF MORTALITY ON AGE STRUCTURE IN A POPULATION*

Most students will feel that altering the mortality rates should affect age distribution in the population as fertility did in the last investigation. Surprisingly, mortality rates have only a secondary effect on the age distribution.

Students are to alter mortality rates for all age groups and view the results. Realism is not required; in fact, the students should examine a wide variety of changes, both increased and decreased mortalities.

Additional information on mortality trends can also be found in the *RESOURCE MANUAL* and the *STUDENT MANUAL*.

Additional Student Instructions

The student must alter only mortality rates; all other variables should remain the same from run to run. It is easiest if the other variables are set to 1970 values.

Students should be encouraged to use a wide range of mortalities. The larger the range investigated, the clearer the result. Mortalities should be changed for all age groups (as opposed to only infants, as in Investigation #2). Reports should be obtained using either Form 2 (long report) or Form 3 (graph of age distribution); either of these Forms will give the required information. If the student needs to work quickly, he may elect to get reports for selected years only.

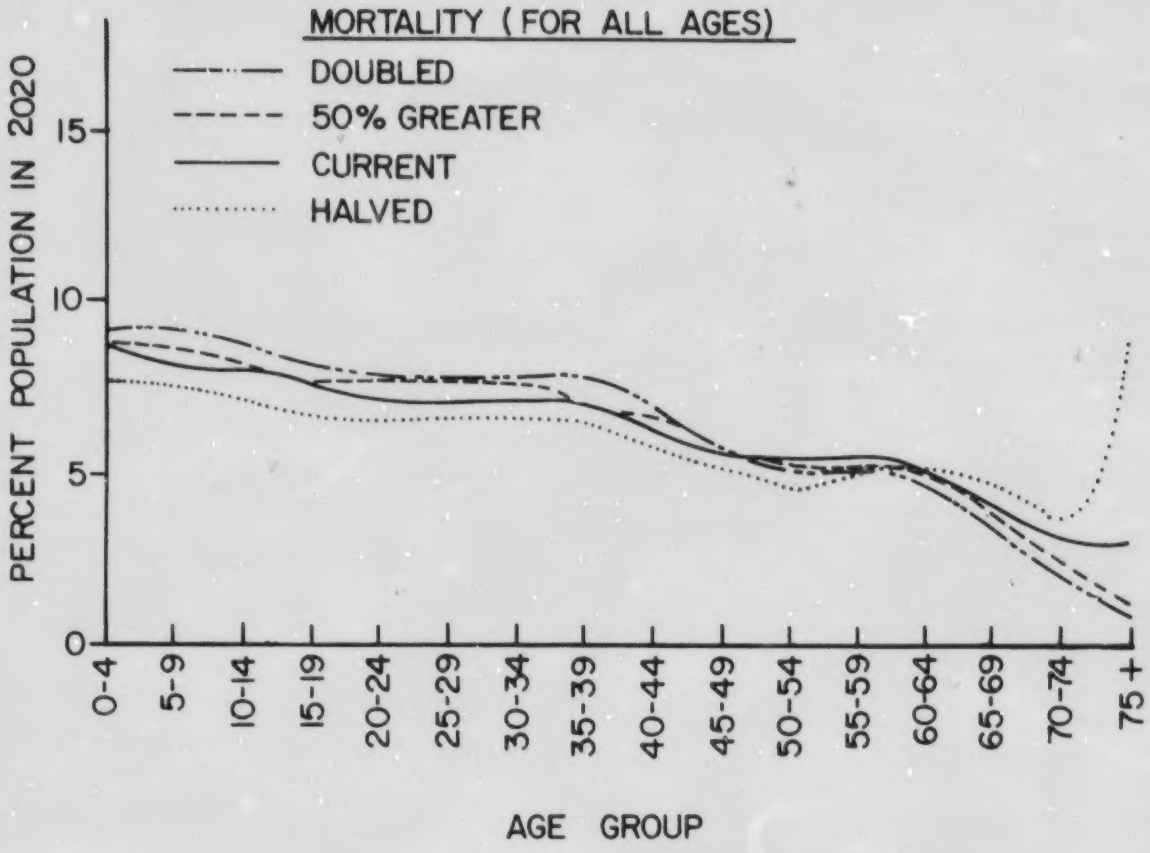
No direct instructions as to organization of data is given in the *STUDENT MANUAL*. You may wish to instruct the students to organize their data in a particular way. (See Sample Results for suggestion.)

Sample Results

Let's say a student chooses to investigate the following changes in mortality:

Trial 1 - doubled mortality for all ages
Trial 2 - 50% increase in mortality for all ages
Trial 3 - no change in mortality (1970 mortalities)
Trial 4 - 50% decrease in mortality for all ages

The results of all of these trials were compiled on a graph showing the age distribution as percentages of the total population predicted for the year 2020. Any other year might have been selected for analysis, but the longer the time period, the clearer the results, generally.



Students should be able to conclude that while mortality has an effect on the size of the population, it does not radically affect the age structure of the population. The one exception is demonstrated in the oldest age category, but this is not a real effect since any percentage change for the oldest group represents a much larger absolute change in this group than in any other group. (The students may wish to use a constant change in mortality rather than a percentage change.)

Students should be encouraged to compare this result with the results of Investigation #4. They should be able to conclude that fertility is usually the prime determinant of age structure in a population.

Sample Answers to Student Follow-up Questions

1) *IF THERE WERE A DRASTIC INCREASE IN MORTALITY IN THE FUTURE CAUSED, SAY, BY MASSIVE AIR POLLUTION, WOULD THE AGE DISTRIUUTION BE AFFECTED? IF SO, IN WHAT WAY?*

This question is open to interpretation. If the student interprets the question as meaning there will be a large increase in mortality for all ages, then his response should mirror the results of the experiment. However, if the student feels that the very young or very old or both will be particularly hard hit, then the student's response may be somewhat different. In class, it is suggested that you examine the student's assumptions relative to this question and then use *USPOP* if necessary to see if his conclusion is valid.

2) *IF ALL AGES HAD A LOWER MORTALITY, WHICH AGE GROUP WOULD SHOW THE GREATEST PERCENTAGE INCREASE? HOW DO YOUR RESULTS INDICATE THIS?*

If all ages were to have identical decreases in per cent mortality, then the older ages would benefit the most. This is indicated by Trial 4 of the Sample Results.

3) *IF CURRENT MORTALITY CONDITIONS CONTINUED FOR THE NEXT 50 YEARS, WOULD THE YOUNG (LESS THAN 30) STILL DOMINATE THE POPULATION?*

The current median age in the United States is less than 30. Should mortality and fertility stay at 1970 levels, *USPOP* projects a median age of about 37 in 2020. This indicates that the dominance of the young would be waning, but still strong.

4) *IF ALL MORTALITY RATES WERE TO DECREASE SUBSTANTIALLY, WHAT IMPACT WOULD THAT HAVE ON THIS COUNTRY?*

The question is open to discussion. Try to channel discussion in such a way that the students must support their conclusions with their collected data.

VI. ADDITIONAL QUESTIONS FOR CLASS DISCUSSION

Should the United States make population limitation a major aim in future years?

If the United States determines that it is necessary to limit future population growth, what factor(s) should be considered of prime importance?

In what ways has the United States adjusted its government and life style to reflect the large number of young people in the population?

What changes do you feel necessary for the future?

For additional ideas and investigations see the *USPOP RESOURCE MANUAL*:

Readings

Class exercises

Further student investigations

DIGITAL EQUIPMENT CORPORATION

RESOURCE HANDBOOK $.50

education

HUNTINGTON II Simulation Program - USPOP

60

computers are for kids — digital — EduSystems—expandable, economical

DEC EDUCATIONAL PUBLICATIONS

A partial list of the publications in the continuing series of curriculum material published by DEC for use with EduSystems and RSTS are listed below. Please inquire directly for prices on classroom quantities.

Additional publications may be obtained from:

Software Distribution Center
Digital Equipment Corporation
Maynard, Massachusetts 01754

Populution: Self-teaching BASIC Workbook	$2.00
BASIC Matrix Operations	$1.00
Computer-Augmented Calculus Topics	$1.50
Problems For Computer Mathematics	$1.25
Advanced Problems For Computer Mathematics	$2.00
BASIC Application Programs	
Mathematics I	$1.00
Mathematics II	1.00
Science	1.00
Business and Social Studies	1.00
Plotting	1.00
Huntington I Application Programs	
MATHEMATICS	$2.00
TEACHER ASSISTANCE	1.00
Huntington I Simulation Programs	
BIOLOGY	$1.00
CHEMISTRY	2.00
EARTH SCIENCE	1.00
PHYSICS	2.00
SOCIAL STUDIES	1.00
Huntington II Simulation Modules	
Student Workbook	$0.30
Teacher's Guide	.30
Resource Handbook	.50
Program Paper Tape	1.00

RESOURCE
MANUAL

USPOP

UNITED STATES POPULATION STUDY

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HUNTINGTON TWO COMPUTER PROJECT

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13 June 1973

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USPOP

RESOURCE MANUAL

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I. WHY USE *USPOP*

The current growth rate of the world's population is about 2% per year; while this rate may seem small enough, the U. S. National Academy of Sciences has projected that if this growth rate had prevailed since the time of Christ, there would now be 100 persons per square foot of the earth's surface. Given today's larger population, a continuing growth rate of 2% per year would lead to the same unbelievable population densities in only a few centuries. Clearly, this rate of population growth cannot be maintained indefinitely.

This idea of a population threat was not well defined for the average person even ten years ago; today the population explosion is a deep and troubling concern for many grade school children. For this reason, an analytical approach to the problem of population growth and control is as important as it is appropriate in secondary education today.

In general, the teacher is as restricted in the study of population problems as the student. The problem of human population growth, when fully analyzed, is a highly complex mathematical phenomenon; not only are such obvious factors as birth rate and death rate important, but the sex ratio of offspring, time of first birth, and differential mortality also play a critical role. For example, while the United States is worrying about overpopulation, countries such as France worry about underpopulation. In the case of these two countries, the main difference lies in the age structures of their respective populations. In France about 30% of the population is over 50, so that a substantial number of women are past reproductive age. This results in fewer births per person and declining population.

With these ideas in mind, the HUNTINGTON TWO PROJECT embarked on the development of a human population model that could be used in the classroom and as an educational tool, as well as in the laboratory. *USPOP* is based on a model quite close to that used by U. S. Government demographers in their population projection work. Several simplifying assumptions had to be made since we were restricted in the degree of complexity we could achieve on a so-called minicomputer; but comparisons of *USPOP* and government projections indicate that errors due to these assumptions are relatively small.

USPOP has been developed primarily to provide the student with laboratory experiences, or to facilitate individualized learning about population factors. To this end, the *STUDENT MANUAL* contains suggested investigations. The Manual covers the effects of fertility, mortality, and birth distribution on both population size and age structure. All these investigations are basic in both approach and necessary student skills. More advanced investigations may be found in the *RESOURCE MANUAL*.

No teacher is likely to ask his or her students to carry out all five of the laboratory investigations. These have been included to allow the teacher to choose investigations that best complement the course of study, or to accommodate the teacher who feels it important to have each group of students tackle a unique problem.

Each investigation in the *STUDENT MANUAL* examines the effect of a single variable. The student is given an introductory reading that explains *USPOP* in general and his problem in particular. He is then given a suggested procedure that may be used to solve the problem. These suggestions are quite general, however, and depending on the skill of your class in biological investigation, you may decide to supplement them with additional instructions found in the *TEACHER MANUAL*. After completion of the investigation, the student is presented with several questions that can be used to evaluate his or her achievement. Sample answers to these questions are also supplied in the *TEACHER MANUAL*.

II. BACKGROUNDS ON HUMAN POPULATION STUDY

A. History of Demography

Demography, the study of populations, existed long as a discipline before it received its current name. In 1855, Guilliard coined the term from the Greek word *"demos"* meaning people. Demography had its genesis in the very earliest census gathering. The need to know the size and nature of the population grew as government became more centralized. There is evidence to indicate that an extensive census was taken during the reign of King David (about 1000 B.C.), and both the Greeks and Romans clearly used census data in their planning.

The Romans were concerned with population planning to such an extent that they attempted to legislate an increase in birth rate by denying childless women the right to wear jewelry. It should be noted that they met with very little success.

Modern periodic census-taking started in the year 1666 with a Canadian census. With each passing year the mound of data has grown; had demography failed to make use of developing statistical techniques, census-taking would have soon become impossible. Demography was one of the first biological fields to make use of quantitative methods, and doing census work today is practically synonymous with computer technology, because of the vast amounts of information that have to be processed in order to administer to the complex needs of the population.

It is not enough to know what has taken place, however; it is often necessary to plan projects many years into the future. This need brought about a second phase of human demography -- population projection. Naturally, early projection techniques were crude. The Greeks attempted to model the growth of population considering such facts as birth and immigration versus mortality and emigration. By the late 1500's, certain Italian demographers had begun to study the role of environmental limitations. Today demographers have developed a complex set of variables to describe the behavior of population.

Compared with early population projections, today's work seems accurate indeed. Yet, for all the statistical information available, no definite answer as to future population is ever possible; there are always contingencies which cannot be predicted. For this reason, government demographers never make a single projection. Entire series of projections are made, with a different set of assumptions for each projection. In this way, the likelihood of having a projection which approximates reality is increased.

In any project many variables have to be evaluated. Some of the most important variables are fertility, birth distribution, sex ratio, and mortality. These four variables interact with a fifth: age distribution.

B. Fertility

Fertility can be thought of as the number of live births the average woman can be expected to have over her entire reproductive life span. This term is more biologically precise than birthrate (which is in units of births per 1000 population), because it is unaffected either by the sex or age distribution of the population.

Fertility varies from country to country and from time to time. Underdeveloped countries tend to have high fertility, as well as high mortality rates; fertility as high as 6-10 children per female is not at all uncommon. Industrialized countries, on the other hand, have both lower fertility and lower mortality rates. Fertility in industrialized countries is generally between 2.0 and 4.0.

Fertility in the United States has varied greatly over the past 50 years, as shown in the chart below. Variations in fertility have been correlated with both the social and economic conditions in the country.

Year	Fertility (children per female)
1920	3.3
1925	3.0
1930	2.5
1935	2.2
1940	2.3
1945	2.5
1950	3.1
1955	3.6
1960	3.7
1965	2.9
1970	2.45
1972	2.1 estimated

During the depression in the 1930's, fertility was low and this low pattern continued throughout World War II. Starting in the late 40's and early 50's, fertility has shown the effects of the post-war baby boom. Fertility continued to grow throughout the 50's into the early 60's as former servicemen continued to expand their families. By the late 60's, however, these families passed out of the reproductive pool and fertility again decreased.

Others have tried to explain this fertility shift in economic terms. The 30's and the war years were periods of economic uncertainty as well as low fertility. While many economists predicted serious economic troubles for the United States in the post-war years because of the problems of adjusting to a peace-time economy, the problems never developed. The 1950's were a time of great economic growth; fertility and average family size also grew throughout this period. Starting with the 70's, the economy again became uncertain, and at this time fertility again showed a dip.

Fertility today is currently at a level very near that recorded during the midst of the depression. Opinion as to why this should be so is divided. Some see this change as a permanent shift in attitude about family size in women entering the reproductive pool, while others interpret this drop in fertility as an effect of an uncertain economy, saying that fertility has dropped because many women are delaying their families. In either case, the next few years should tell if fertility will remain low or swing upward again.

C. Birth Distribution

When children are born to a woman is often as important as the number of children. Since we used the term fertility to describe the average number of offspring, we may describe birth distribution in terms of the fraction of fertility expressed for each year of the woman's reproductive period.

Just as fertility has varied in the United States' recent history, so has birth distribution.

TABLE 2 - PER CENT FERTILITY IN EACH 5-YEAR PERIOD

A G E	1970	1965	1960	1955	1950	1945	1940
10-14	.2	.2	.1	.1	.1	.2	.1
15-19	14.3	12.6	12.4	12.8	13.0	10.2	11.8
20-24	33.8	33.2	35.2	33.6	31.8	27.9	29.5
25-29	28.5	27.6	26.9	26.6	27.2	26.5	26.7
30-34	14.7	16.2	15.4	16.3	16.7	20.1	18.1
35-39	6.6	7.9	7.8	8.3	8.6	11.5	10.0
40-44	1.8	2.2	2.1	2.2	2.4	3.3	3.4
45-49	.1	.1	.1	.1	.2	.3	.4

This chart shows that women today are having their children earlier. There appear to be two reasons for this effect. First, women today are having fewer children, so we would naturally expect a greater percentage of their offspring to be born during these women's earlier reproductive years. Secondly, there is the effect of World War II. Women who would ordinarily have had their children during the war years delayed their families, so that their children were born at a later time in their lives. If these two effects are taken into account, no real shifts in birth distribution can be found for recent years.

When we view birth distribution around the world, however, we find many real differences. In countries such as India, a sizable portion of the females are married in their very early teens and have their first child before they are 15 years of age. Other countries have a tradition of delayed fertility. The classical example is Ireland, where custom has delayed marriage and first children to the late 20's and early 30's.

Even if fertility were to remain constant, a change in birth distribution would result in a change in population growth. This avenue of population control has been advocated for countries with severe population problems, but it is probably doomed to failure since it often means the changing of ingrained social and religious patterns.

D. Sex Ratio of Offspring

More males are born than females. The sex ratio today is about 51.5% male births to 48.5% female. Why is this so?

In spite of the fact that according to Mendelian Laws there should be an equal chance of a male and female being conceived, there is good proof that this is not the case. Estimates made from the examination of spontaneous abortions (miscarriages) indicate that up to 170 males are conceived for every 100 females. While this estimate is probably too high, no estimates place the ratio near 50-50.

Reasons for this surplus production of males are as numerous as they are uncertain. This being the case, one can have a good deal of fun speculating without fear of being contradicted. Some biologists have maintained that males are conceived more often because the sperm carrying the Y chromosome is lighter than the sperm carrying the X chromosome and is, therefore, more likely to reach the egg cell.

Others have sought to explain this phenomenon in evolutionary terms. Some of this reasoning rests on the biological fact that the male fetus is less strong than his female counterpart. If in the past, the argument goes, living conditions were much less favorable, especially for the pregnant female, intrauterine conditions must also have been poor. Such a

state would naturally favor the production of females. Since a balanced production of males and females would seem to be biologically favorable, natural selection would favor those groups of pre-humans that had had a tendency to produce a surplus of male conceptions. If this biological trend were continued to the present day when prenatal conditions have been vastly improved, a surplus of males would be born.

Many other interesting phenomena have been associated with sex-ratio differences. It has been noted that males occur in a higher percentage of first births and decline in majority with an increase in the mother's age. Scientists have used the argument about prenatal conditions to explain this, saying that there is a more hostile intrauterine environment in women of older age, a condition that favors the female fetus. Also, increases in male births have been recorded during wartime, a phenomenon that is a good deal harder to explain.

A frequently cited cause of sex-ratio difference is race. It now appears that these differences are not real, but a result of under-registration of female births by racial minorities.

Challenge your students to think of other reasons why more males might be born than females. It could be a very interesting way to review both evolution and reproduction!

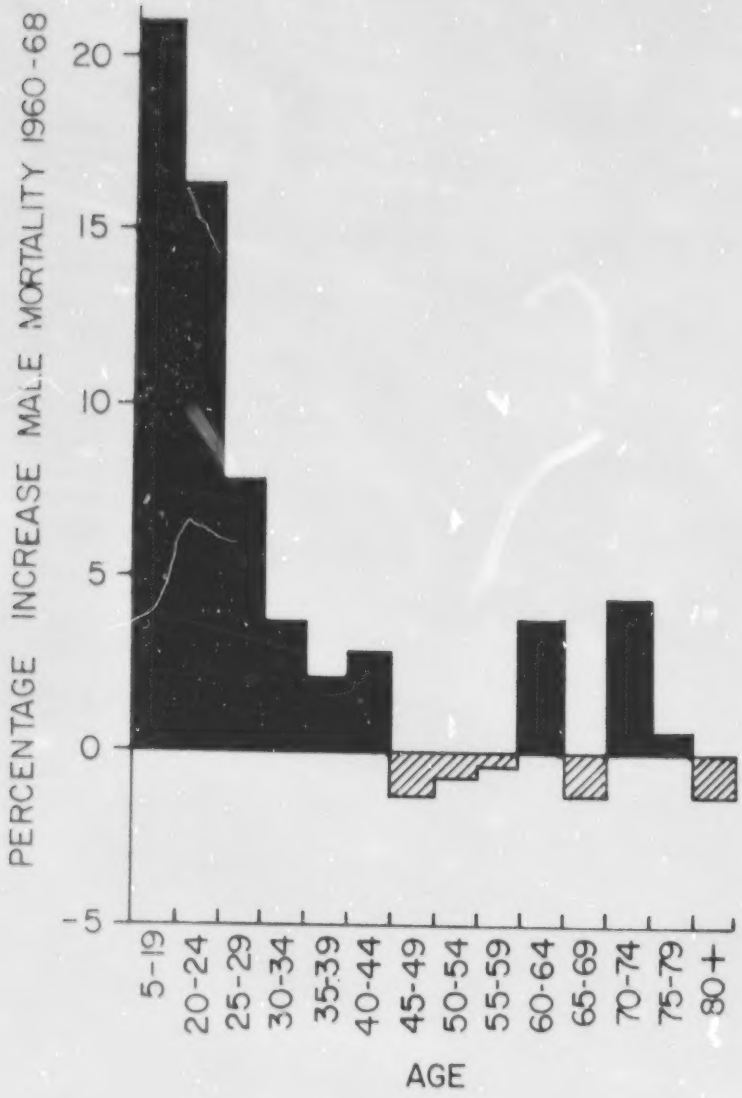
E. Mortality

Two disturbing facts have recently become evident concerning mortality in the United States. First, infant mortality in the U. S. is relatively high when compared with mortality in other advanced nations. Secondly, the U. S. is one of three nations in the entire world in which male life expectancy has actually fallen in the last 10 years.

At the present time the United States ranks 14th in infant mortality. This is a shocking figure, especially for a country that prides itself on being the most advanced technologically. The general infant mortality rate is approximately 28 deaths per 1000 live births. If you are a member of the lower class or an ethnic minority, things are even worse: infant mortality rises to 33 deaths per 1000 live births in these groups. Are there any biological factors that would explain this high rate? The answer is apparently no. Infant mortality for the upper-income brackets, where expensive prenatal care and counseling can be afforded, is only 17 per 1000 births. This would seem to indicate that the problem is not biological, but social.

Recently there have been attempts in the United States to come to grips with this problem. The March of Dimes is currently advertising through the media to make women aware of the importance of prenatal medical care. But there is considerable doubt that the U. S. has the necessary personnel or facilities for all women to have the necessary prenatal care required to lower our infant mortality to a more acceptable level.

The problem of increased male mortality is more complex. After a steadily increasing rise in life expectancy throughout the 20th century, the United States has for the first time seen a drop in life expectancy among its male population, while females have continued to increase their life expectancy over the last 10 years. (See GRAPH 1 below.)



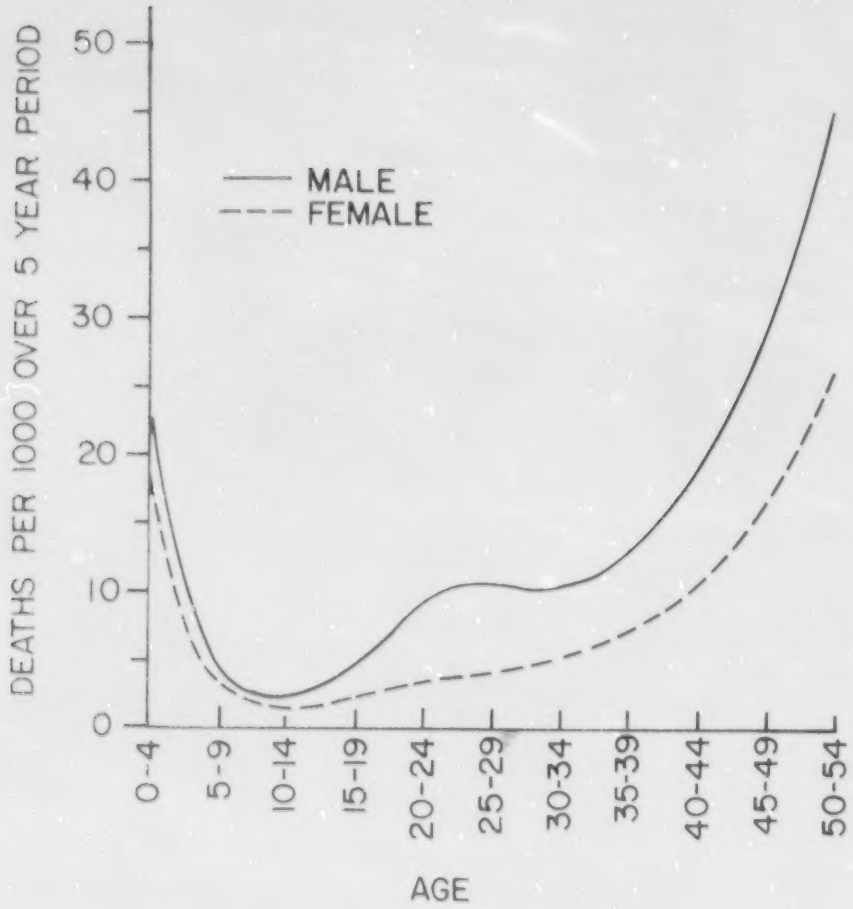
GRAPH 1

What has caused this increase in male mortality? The United States has just completed a statistical survey to answer this question.* For

* "Leading Components of Upturn in Mortality for Men," DHEW Publication No.(HSM) 72-1008. (The Department of Health, Education and Welfare's document is available for 50¢ from the U.S. Government Printing Office.)

those males over 30 there has been a sizable increase in the incidence of fatal lung cancer and other smoking-related diseases (such as emphysema) over the past 10 years. Among males in their late teens and early twenties the marked increases in mortality over the past 10 years have largely been a result of automobile-related deaths, suicide and homicide. This pattern has been substantially the same for all racial and economic groups.

The reasons for these increases in mortality are still open to controversy, but much more study is clearly warranted, since a continuation of this trend would result in a large surplus population of females in their reproductive years. Such a situation would have to lead to drastic changes in the operation of our society.



GRAPH 2

GRAPH 2 shows mortality/1000 versus age for both males and females. Two things to notice are (1) that females always have lower mortality, and (2) the especially high mortality for males in their 20's.

F. Age Distribution

As mentioned earlier, all the other factors: fertility, birth distribution, sex ratio and mortality tend to influence the age structure of the population. In the United States today, the age structure is such that the median age is approximately 28 years. News media have often estimated a lower number when discussing the "youth revolution," but the fact remains that those over 30 are in the minority.

Countries with high birth rates and high mortality tend to have very young populations, while countries with low birth rates and low mortality have uniformly distributed or old-age-dominant distributions. This observation has led to the concept of *demographic transition*, a process wherein falling mortality rates unaccompanied by falling birth rates produce a population explosion, with the birth rate declining only 100 years later. European countries underwent demographic transition during the 19th century. The surplus population produced during this process had a "safety valve" for expansion: namely, the North and South American continents.

Today, many countries are undergoing a similar demographic transition. This transition is producing even larger increases in population (from 2-3% per year), and there is no safety valve for expansion. The consequence is tremendous overcrowding and depletion of resources necessary for successful completion of this transition.

III. RUNNING *USPOP*

A. Explanation of Program Inputs

Due to the exceedingly large amount of information needed for the *USPOP* model, operational shortcuts were designed into the program. Instead of requiring the student to input over 80 numbers, the program stores (in DATA statements) the latest available statistics describing the U. S. population in 1970. The student should be encouraged to make maximum use of these statistics, as this will save him a great deal of time.

Should the student desire to use other variable values, the program allows him to try numerous values for all the variables. Variable values may also be changed during a RUN (by requesting a Number 4 Report).

What follows is an elaboration of the computer instructions given in the *STUDENT MANUAL*:

#1 DO YOU WANT REPORTS (1) EVERY 5-YEAR INTERVAL OR (2) SELECTED YEARS?

Typing a "2" will enable the student to save a great deal of time in the case of a long-term projection.

#2 YEAR AT START OF PROJECTION?

If the student is going to make extensive use of the data stored in the program, he should type "1970". If he is using data collected for another year, that year number should be typed.

#3 DO YOU ASSUME STANDARD FERTILITY (1=YES, Ø=NO)?

This is a yes/no answer (1=yes, and Ø=no). If the student types "1", the computer will read the fertility from the 1970 data and skip to question #5.

If the answer was "no" (Ø), the computer will ask:

#4 FERTILITY IN YEAR _____?

The year number entered in #2 above should appear in the blank.

#5 WILL FERTILITY (1) STAY CONSTANT OR (2) CHANGE SLOWLY TO A NEW LEVEL?

The student enters the number that best represents the assumption he wishes to explore. If he selects "1", the computer will skip to question #8.

If the answer was "2":

#6 WHAT FERTILITY WILL BE STABLE?

Student types fertility that he assumes will eventually stay constant. (NOTE: at a later time in the RUN, this assumption may be changed.)

#7 HOW MANY DECADES BEFORE FERTILITY REACHES STABILITY?

After the student answers Questions #6 and #7, the computer will have evaluated all factors related to total fertility.

#8 DO YOU ASSUME STANDARD BIRTH DISTRIBUTION (1=YES, Ø=NO)?

This is also a yes/no answer. If the student types "1", 1970 data will be read from storage and the program will skip to question #10.

If the student typed "no" (Ø):

#9 PER CENT OF FERTILITY OCCURRING IN FEMALES AGES:
10-14?
15-19?
.. ..
45-49?

Student responds to these questions according to the situations he wishes to explore. The total for percentages must add to 100. After computer checks addition, program proceeds to question #10.

#10 DO YOU ASSUME STANDARD MORTALITY (1=YES, Ø=NO)?

Again this is a yes (1) — no (Ø) question. If student types "1", 36 pieces of 1970 mortality data are read from the program. If he types "Ø", he may modify some or all of the male and female mortalities.

If the student types "1", the program skips to question #13.

Otherwise:

#11 CHANGE IN MORTALITY OCCURRING IN FEMALES (FROM AGE, TO AGE)?

Student sets lower and upper limits for range of age groups for which he wants to change mortality. For example, if he wants to change all mortalities, he should type "0,75". If the student does not wish to change the mortality rate for any female age group, he should type "Ø,Ø".

The computer then responds with:

GROUP	CURRENT DEATH/1000	NEW VALUE
0-4	17.8	?
5-9	2.8	?
10-14	1.5	?
15-19	2.2	?
.	.	.
.	.	.
75 & older	337.3	?

Following each question mark the student should enter the new value of mortality for that age group.

#12 CHANGE IN PER CENT MORTALITY OCCURRING IN MALES (FROM AGE, TO AGE)?

Exactly the same procedure as above, except that male mortality is now considered. Typing "Ø,Ø" will result in no change.

#13 DO YOU ASSUME STANDARD POPULATIONS (1=YES, Ø=NO)?

Yes/no question (1=yes, Ø=no). If student types "1", the population is set equal to the 1970 population and computer skips to #16.

If student answers "no" (Ø):

#14 POPULATION CHANGE IN FEMALE GROUPS (FROM AGE, TO AGE)?

If student wishes to change the size of all population cohorts, he would type "Ø,75". Should he want to make changes for only one or two age groups, leaving the rest at 1970 values, he might type "2Ø,29", for example.

The computer would respond with:

GROUP	CURRENT POPULATION MILLIONS	NEW VALUE
20-24	8.5	?
25-29	6.9	?

The student would then enter new values for the appropriate cohort populations in millions (decimal numbers allowed).

#15 POPULATION CHANGE IN MALE GROUPS (FROM AGE, TO AGE)?

Same procedure as for #14.

#16 REPORT: 1) SHORT 2) LONG 3) GRAPH 4) CHANGE ASSUMPTIONS 5) END?

Student can select any output format that he requires (for examples see Sample Runs included), obtain an option to change any variable values, or conclude the RUN by typing the appropriate number.

The computer will then carry out all mathematics and issue a report in the proper format, if a report is requested. After this, the computer will return to question #16 for further instructions.

B. Additional Sample Runs (for more examples see *USPOP TEACHER MANUAL*)

In the Sample Run below, a student is carrying out a projection in which he has altered birth-distribution assumptions. This facet of demography is studied in Investigation #2 in the *STUDENT MANUAL*.

```
DO YOU WANT REPORTS 1) EVERY 5 YEAR INTERVAL
OR 2) SELECTED YEARS ?1

YEAR AT START OF PROJECTION ?1970

DO YOU ASSUME STANDARD FERTILITY (1=YES,0=NO) ?1
WILL FERTILITY (1) STAY AT 2.45  OR (2) CHANGE SLOWLY
TO A NEW LEVEL ?1

DO YOU ASSUME STANDARD BIRTH DISTRIBUTION (1=YES,0=NO) ?0
PCT. FERTILITY OCCURING IN FEMALE AGES:
 10 - 14  ?30
 15 - 19  ?40
 20 - 24  ?30
 25 - 29  ?0
 30 - 34  ?0
 35 - 39  ?0
 40 - 44  ?0
 45 AND OLDER ?0

DO YOU ASSUME STANDARD SEX RATIO (1=YES,0=NO) ?1

DO YOU ASSUME STANDARD MORTALITY (1=YES,0=NO) ?1

DO YOU ASSUME STANDARD POPULATION (1=YES,0=NO) ?1

REPORT:1)SHORT 2)LONG 3)GRAPH 4)CHANGE ASSUMPTIONS 5)END ?1

YEAR 1970      POP=  204.8  MILLION          FERTILITY 2.45

REPORT: ?1

YEAR 1975      POP=  218.9  MILLION          FERTILITY 2.45

REPORT: ?1

YEAR 1980      POP=  233.9  MILLION          FERTILITY 2.45

REPORT: ?1

YEAR 1985      POP=  247.5  MILLION          FERTILITY 2.45
```

```
REPORT: ?1
YEAR 1990      POP=  261  MILLION          FERTILITY 2.45
REPORT: ?1
YEAR 1995      POP=  275.9  MILLION        FERTILITY 2.45
REPORT: ?1
YEAR 2000      POP=  292.4  MILLION        FERTILITY 2.45
REPORT: ?5
ANOTHER PROJECTION (1=YES, 0=NO) ?0
```

In the following RUN, the student is investigating the effect of a slowly lowering fertility. Note the effect on the reports.

```
DO YOU WANT REPORTS 1) EVERY 5 YEAR INTERVAL
OR 2) SELECTED YEARS ?2
```

BY TYPING "2" THE STUDENT MAY SKIP REPORTS.

```
YEAR AT START OF PROJECTION ?1975

DO YOU ASSUME STANDARD FERTILITY (1=YES,2=NO) ?2
FERTILITY IN 1975  ?2.36
WILL FERTILITY (1) STAY AT 2.36  OR (2) CHANGE SLOWLY
TO A NEW LEVEL ?2
```

CHOICE "2" MAKES SLOW SHIFTS IN FERTILITY POSSIBLE WITHOUT INTERRUPTING THE PROGRAM. FERTILITY WILL SLOWLY DROP TO 1 AND THEN REMAIN AT THAT LEVEL.

```
WHAT FERTILITY WILL BE STABLE ?1
HOW MANY DECADES UNTIL FERTILITY REACHES 1  ?3.5

DO YOU ASSUME STANDARD BIRTH DISTRIBUTION (1=YES,2=NO) ?2
PCT. FERTILITY OCCURING IN FEMALES AGES:
 10 - 14  ?.5
 15 - 19  ?23
 20 - 24  ?40
 25 - 29  ?23
 30 - 34  ?13
 35 - 39  ?5
 40 - 44  ?4.5
 45 AND OLDER ?0

DO YOU ASSUME STANDARD SEX RATIO (1=YES,2=NO) ?2
PERCENT FEMALE BIRTHS ?30
```

STUDENT HAS CHANGED THE BIRTH SEX RATIO SO 30% OF ALL LIVE BIRTHS ARE FEMALE AND 70% ARE MALE.

```
DO YOU ASSUME STANDARD MORTALITY (1=YES,0=NO) ?1
CHANGE IN MORTALITY OCCURING IN FEMALES
GROUPS (FROM AGE, TO AGE) ?0,4
GROUP          CURRENT          NEW VALUE
               DEATH/1000
 0 - 4          17.8             ?13
CHANGE IN MORTALITY OCCURING IN MALES
GROUPS (FROM AGE, TO AGE) ?0,4
GROUP          CURRENT          NEW VALUE
               DEATH/1000
 0 - 4          23.5             ?14

DO YOU ASSUME STANDARD POPULATION (1=YES,0=NO) ?0

CHANGE IN FEMALE POPULATION
GROUPS (FROM AGE, TO AGE) ?0,0

CHANGE IN MALE POPULATION
GROUPS (FROM AGE, TO AGE) ?15,30
GROUP          CURRENT          NEW VALUE
          POPULATION MILLIONS
 15 - 19        2.3              ?2
 20 - 24        3.6              ?4.3
 25 - 29        6.3              ?3.4
 30 - 34        5.7              ?2.8

REPORT:1)SHORT 2)LONG 3)GRAPH 4)CHANGE ASSUMPTIONS 5)END ?2

YEAR 1975      POP=  192.4  MILLION          FERTILITY 2.06
 AGES     FEMALES <-MILLIONS-> MALES          PCT. TOTAL
 0 - 4          8.4              8.7           8.9
 5 - 9          9.7              10.1          10.3
 10 - 14        10.2             10.5          10.8
 15 - 19        9.4              8             9
 20 - 24        8.5              4.3           6.6
 25 - 29        6.9              3.3           5.3
 30 - 34        5.8              2.7           4.4
 35 - 39        5.7              5.5           5.8
 40 - 44        6.1              5.8           6.1
 45 - 49        6.9              5.9           6.3
 50 - 54        5.7              5.3           5.7
 55 - 59        5.2              4.7           5.1
 60 - 64        4.6              4             4.5
 65 - 69        3.7              3             3.5
 70 - 74        3.0              2.3           2.9
 75 AND OVER    4.6              2.9           3.9
```

TYPING "0" ALLOWS CHANGES IN STARTING YEAR POPULATION.

"0,0" MEANS NO CHANGES

OLD POPULATION IS GIVEN, THEN STUDENT IS ASKED FOR NEW FIGURE. ALL VALUES ARE IN MILLIONS. EXAMPLE: 3.4 MEANS 3,400,000.

IF REPORTS ARE TO BE GIVEN IN SELECTED YEARS:

AT THE END OF EACH REPORT THE COMPUTER ASKS FOR THE YEAR OF NEXT REPORT. ANY "FUTURE" YEAR MAY BE TYPED, BUT THE COMPUTER CAN ONLY RESPOND WITH AN INCREMENT OF 5 FROM THE STARTING YEAR.

NOTE THE GRADUAL FALL IN FERTILITY

```
YEAR FOR NEXT REPORT ?1985

REPORT: ?1

YEAR 1985     POP=  206.9  MILLION        FERTILITY 1.75714
YEAR FOR NEXT REPORT ?1995

REPORT: ?1

YEAR 1995     POP=  218.1  MILLION        FERTILITY 1.45833
YEAR FOR NEXT REPORT ?2005

REPORT: ?1

YEAR 2005     POP=  216.2  MILLION        FERTILITY 1.15143
YEAR FOR NEXT REPORT ?2015

REPORT: ?2

YEAR 2015     POP=  207.3  MILLION        FERTILITY 1.
```

AGES	FEMALES <-MILLIONS-> MALES		PCT. TOTAL
0 - 4	1.7	3.9	2.7
5 - 9	2.1	4.7	3.3
10 - 14	2.7	6.1	4.2
15 - 19	3.3	8.4	5.9
20 - 24	4.8	10.4	7.3
25 - 29	5.3	11.4	8.1
30 - 34	5.4	11.6	8.2
35 - 39	5.2	11	7.8
40 - 44	3.8	8.8	6.5
45 - 49	3.9	3.7	5.5
50 - 54	13	3.7	2.5
55 - 59	8.9	6.9	7.6
60 - 64	7.6	3.4	5.3
65 - 69	5.7	8.3	3.8
70 - 74	4.2	1.4	2.7
75 AND OVER	5.6	4.1	4.7

```
YEAR FOR NEXT REPORT ?2025

REPORT: ?1

YEAR 2025     POP=  191.2  MILLION          FERTILITY 1.
YEAR FOR NEXT REPORT ?2035

REPORT: ?1

YEAR 2035     POP=  168.1  MILLION          FERTILITY 1.
YEAR FOR NEXT REPORT ?2045

REPORT: ?1

YEAR 2045     POP=  148.8  MILLION          FERTILITY 1.
YEAR FOR NEXT REPORT ?2055

REPORT: ?1

YEAR 2055     POP=  116  MILLION            FERTILITY 1.


YEAR FOR NEXT REPORT ?2330

REPORT: ?0


YEAR 2330     POP=  31.6  MILLION           FERTILITY 1.
 AGES     FEMALES <-MILLIONS-> MALES        PCT. TOTAL
 3 - 4          3.9              3.6        3
 5 - 9          3.8              3.7        3.7
 10 - 14        3.5              3.8        3.4
 15 - 19        3.6              4          5.0
 20 - 24        3.7              4.1        5.3
 25 - 29        3.8              4.2        6.5
 30 - 34        4.0              4.3        7.2
 35 - 39        4.0              4.2        7.4
 40 - 44        4                4.2        7.5
 45 - 49        4                4.3        7.5
 50 - 54        4                4.3        7.5
 55 - 59        4                4.2        7.3
 60 - 64        4                4.1        6.9
 65 - 69        3.9              3.9        6.1
 70 - 74        3.8              3.7        5
 75 AND OVER    1.5              1          8.2

YEAR FOR NEXT REPORT ?2040

REPORT: ?5

ANOTHER PROJECTION (1=YES, 3=NO) ?3
```

SELECTED YEAR OPTION ALLOWS STUDENT TO EXAMINE LARGE TIME INTERVAL.

TO END PROJECTION, IT IS STILL NECESSARY TO SET A DATE FOR NEXT REPORT.

IV. The *USPOP* MODEL

A. About the Model

USPOP can be used to model any human population. In the course of developing the program, we made certain simplifying assumptions in order to reduce the size of the program and make it usable on smaller computers. As it stands, *USPOP* makes use of over 80 variables to delineate population behavior characteristics; if the model were more sophisticated, even more variables would be required to describe the population's characteristics.

The assumptions under which *USPOP* operates will not affect the model's performance to any noticeable extent if the population being modeled is sufficiently large; for a smaller population (under 500,000), however, some deviation may occur.

Clearly, in a model of a large population, each person cannot be depicted individually and assigned a unique set of variables for descriptive purposes. The individuals within a population are always placed into similar groups called cohorts. Closeness of age is one of the prime characteristics of a cohort; in addition, cohorts are often defined by sex. Very simple population models consider the population to be composed of either one or two cohorts. (This was the case in the HUNTINGTON TWO simulation, *POP*.) The *USPOP* model considers the population to be composed of 32 cohorts, 16 of either sex. Each cohort is composed of those born in a contiguous 5-year period; therefore, the cohorts cover ages 0 to 4, 5 to 9, 10 to 14.....and 70 to 75. All members of a particular cohort share the general characteristics of the group, as specified in its set of variable values. Naturally this procedure simplifies the calculations involved in making the projection.

The calculations can be made still easier if we are content to look at the population only at 5-year intervals. By doing so, we can view each cohort as "graduating" together into the next age category. Of course, we do incur some error in doing this, but if the population is large enough, the error is usually so small that a 5-year calculating period is not objectionable. (Should you attempt to model a small population, however, you might detect deviations.)

Other Applications of the *USPOP* Model

Although this program was done with U. S. data, it is a general human population model and may be applied to any population -- provided the following statistical information about the population can either be gathered or estimated:

1) Fertility - average number of live births per woman over her reproductive lifetime. For those women still in the reproductive ages, estimates must be made for the number of children they are likely to have. Note that non-reproductive women must also be considered in estimating the fertility.

2) Birth distribution - per cent of total fertility expressed by females of each age category. Estimates of this may be obtained from interviews or from relevant hospital records.

3) Sex ratio of offspring - per cent of live births: female and/or male.

4) Mortality rates - deaths per 1000 individuals in a single cohort over a 5-year period. These will be difficult to obtain. You may elect to use the same figures published for the country as a whole.

5) Populations of each cohort at beginning year. These can be obtained from any census taken for the area which you are modeling.*

Specific Suggestions

- Have your students attempt to obtain the above information for your community; then have them use *USPOP* to project the population of their community into the future. Discuss what these changes could mean to the community and to them personally. (*USPOP* assumes a net immigration of 400,000 individuals per year. To eliminate this, see Part F of Section IV.)

- Run comparative population projections for several countries. Data should be available through the World Health Organization of the United Nations. Have your students write both to WHO and embassies of countries that they are interested in to ask for the above infor[illegible]

B. *USPOP* Model Formulas

1) Total population:

$$P_t = \sum_{i=1}^{16} (M_i + F_i)$$

where M_i equals the ith cohort of males and F_i the ith cohort of females. (Each cohort represents a group born within a 5-year period.) P_t equals the total population at time t. This assumes immigration is constant at 400,000 per year. M_{16} and F_{16} include all those age 75 and over.

*See references for sources in your area.

2) Births in the population:

$$B = f \sum_{i=3}^{10} (D_i \times F_i)$$

where f equals the total fertility, and D_i the per cent fertility expressed by the ith female cohort. The limiting values of i assume that all births occur to females between the ages of 10-49. Also no direct male influence on births is assumed, as no M factor is used.

a) Male births:

$$M_o = mB$$

where m equals per cent of all male births.

b) Female births:

$$F_o = B - M_o$$

3) Fertility determination:

$$f = (f_1 + f_2) / 2$$

Fertility over the 5-year calculating period is assumed to be equal to the mean average of fertility at the beginning of the period (f_1) and fertility at the end of the period (f_2).

4) Mortality:

$$M_{i+1} = M_i \times T_{i+1}$$

$$i = 1, 2, \ldots.14$$

$$F_{i+1} = F_i \times S_{i+1}$$

Number surviving 5-year period (M_{i+1} and F_{i+1}) assumed equal to original number (M_i or F_i) times the probability of survival until the next 5-year interval (T_{i+1} or S_{i+1}), except for the last age category (i=16), where

$$M_{16} = M_{16}T_{16} + M_{15}T_{16}$$

$$F_{16} = F_{16}S_{16} + F_{15}S_{16}$$

These equations assume that all those over age 70 have equivalent mortality rates.

C. Additional Considerations and Assumptions

1) Populations should be large enough so that random fluctuations in size should be negligibly small by comparison.

2) Birth distribution, sex ratio and mortality rates are assumed to be constants for a particular run, although they may be altered through the course of many runs as the student wishes.

3) As noted before, it is assumed that males play no direct role in determining the number of births. If student desires to simulate such phenomena as war or an increase in a sex-related disease such as lung cancer, he must lower not only the number of males in the affected cohorts but the female fertility as well, assuming that a decrease in the number of males will affect female fertility.

4) All major descriptive population variables are assumed to be independent of each other. While this detracts from the realism of the model, it does make it easier for anyone using the program for studying population to determine cause and effect between variables.

5) All cohorts are assumed to be internally homogeneous; thus they may be represented by a single set of constants.

6) Age distribution within a cohort is assumed to be uniform.

7) Immigration represents net immigration. The age distribution of immigrants will stay near 1970 levels and there are equal numbers of each sex.

8) All standard figures are based on data from the Bureau of Census, Current Population Reports, Series P-25, No.493, and Bureau of Census, Statistical Abstracts of the United States, 1972. (See Reference Section for details.)

```
100 REM USPOP - US POPULATION PROJECTION SIMULATION
105 REM COPYRIGHT 1973 STATE UNIVERSITY OF NEW YORK
110 REM DEVELOPED BY J. FRIEDLAND
115 REM PROGRAMMMED BY J. FRIEDLAND, S. HOLLANDER
120 REM LATEST REVISION: JULY 30,1973
125 RESTORE
130 DIMB(10),M(4,16)
135 READY1,F2,J,T,F,I9,R9
140 DATA 0,0,0,0,0,0,0
145 READ B2
150 FORN=3TO10
155 READ B(N)
160 NEXTN
165 READM
170 FORN=1TO4
175 FOR N1=1TO16
180 READ M(N,N1)
185 NEXTN1
190 NEXTN
195 PRINT"DO YOU WANT REPORTS 1) EVERY 5 YEAR INTERVAL"
200 PRINT"OR 2) SELECTED YEARS";
205 INPUT F1
210 IF (F1-1)*(F1-2)<>0 THEN 195
215 PRINT
220 PRINT"YEAR AT START OF PROJECTION";
225 INPUTY2
230 PRINT
235 PRINT"DO YOU ASSUME STANDARD FERTILITY (1=YES,0=NO)";
240 INPUTQ
245 IFQ*(Q-1)<>0THEN235
250 GOSUB880
255 PRINT
260 PRINT"DO YOU ASSUME STANDARD BIRTH DISTRIBUTION (1=YES,0=NO)";
265 INPUTQ
270 IFQ=1THEN285
275 IFQ<>0THEN260
280 GOSUB1010
285 PRINT
290 PRINT"DO YOU ASSUME STANDARD SEX RATIO (1=YES,0=NO)";
295 INPUTQ
300 IFQ=1THEN315
305 IFQ<>0THEN290
310 GOSUB 985
```

```
315 PRINT
320 PRINT"DO YOU ASSUME STANDARD MORTALITY (1=YES,0=NO)";
325 INPUTQ
330 IFQ=1THEN345
335 IFQ<>0THEN320
340 GOSUB1085
345 PRINT
350 PRINT"DO YOU ASSUME STANDARD POPULATION (1=YES,0=NO)";
355 INPUTQ
360 IFQ=1THEN375
365 IFQ<>0THEN350
370 GOSUB 1120
375 FOR N=1TO16
380 LETT=T+M(1,N)+M(2,N)
385 NEXTN
390 IF F=1 THEN 455
395 PRINT
400 PRINT"REPORT:";
405 IFY1=0THEN415
410 GOTO420
415 PRINT"1)SHORT 2)LONG 3)GRAPH 4)CHANGE ASSUMPTIONS 5)END";
420 INPUTR
425 LET F=1
430 IF(R-1)*(R-2)*(R-3)*(R-4)*(R-5)<>0THEN415
435 IFR=5THEN1410
440 IFR<4THEN455
445 GOSUB805
450 GOTO395
455 IFY1=0THEN625
460 IFZ=1THEN495
465 IFF2=1THEN490
470 IFY3>=Y1THEN480
475 LETJ=0
480 LETB2=B2+J
485 GOTO495
490 LET F2=0
495 LETB=(B2+B1)/2
500 LETQ=0
505 FORN=3TO10
510 LETQ=Q+B*M(1,N)*B(N)
515 NEXTN
520 LETQ=Q+174845
525 LETI9=2667
530 LETM(2,16)=M(4,16)*(M(2,16)+M(2,15)+I9)
535 LETM(1,16)=M(3,16)*(M(1,16)+M(2,15)+I9)
540 LETT=M(2,16)+M(1,16)
```

```
545 FORN=0TO13
550 IFN>1THEN565
555 LETI9=2667
560 GOTO 585
565 IFN>7THEN580
570 LETI9=35100
575 GOTO585
580 LETI9=116200
585 LET M(2,15-N)=M(4,15-N)*(M(2,14-N)+I9)
590 LET M(1,15-N)=M(3,15-N)*(M(1,14-N)+I9)
595 LETT=T+M(2,15-N)+M(1,15-N)
600 NEXTN
605 LETM(2,1)=M*Q*M(4,1)
610 LETM(1,1)=(1-M)*Q*M(3,1)
615 LETT=T+M(1,1)+M(2,1)
620 IFY2+Y1*5+4<R9THEN785
625 PRINT
630 PRINT"YEAR";Y2+Y1*5,"POP= ";
635 IFT<1E6THEN650
640 PRINT INT(T/1E5+.5)/10;" MILLION",
645 GOTO655
650 PRINT INT(T+.5),
655 PRINT"FERTILITY";B2
660 LETF=0
665 IFT*(R-1)=0THEN760
670 IFR<>3THEN690
675 PRINTTAB(25);"PCT. TOTAL POP."
680 PRINTTAB(10);"0.........5.........10.........15.......20"
685 GOTO695
690 PRINT" AGES";TAB(9);"FEMALES <-MILLIONS-> MALES","PCT. TOTAL"
695 FORN=1TO16
700 IFN=16THEN715
705 PRINT(N-1)*5;"-";N*5-1;
710 GOTO725
715 IFR=3THEN745
720 PRINT" 75 AND OVER";
725 IFR=3THEN750
730 PRINTTAB(14);INT(M(1,N)/1E5)/10,INT(M(2,N)/1E5)/10,
735 PRINTINT((M(1,N)+M(2,N))*1000/T)/10
740 GOTO755
745 PRINT" 75+";
750 PRINTTAB(10);".";TAB(10+200*(M(1,N)+M(2,N))/T);"*"
755 NEXTN
760 IF F1=1THEN790
765 PRINT"YEAR FOR NEXT REPORT";
```

```
770 INPUT R9
775 IF Y2+Y1*5<R9 THEN790
778 PRINT"YEAR MUST BE GREATER THAN";Y2+Y1*5
780 GOTO765
785 REM YEAR COUNTER
790 LET Y1=Y1+1
795 LETB1=B2
800 GOTO 390
805 PRINT
810 PRINT"WHAT DO YOU WANT TO CHANGE?"
815 PRINT"1-FERTILITY, 2-BIRTH DISTRIBUTION, 3-SEX RATIO"
820 PRINT"4-MORTALITY, 5- POPULATION";
825 INPUTQ
830 IFINT(ABS(Q))<>QTHEN815
835 IFABS(Q-3)>2THEN815
840 IFQ>1THEN850
845 GOTO885
850 IFQ>2THEN860
855 GOTO1010
860 IFQ>3THEN870
865 GOTO985
870 IFQ>4THEN1120
875 GOTO1085
880 IFQ=1THEN910
885 PRINT"FERTILITY IN";Y2+Y1*5;
890 IFY1=0THEN900
895 LETF2=1
900 INPUTB2
905 IFB2<0THEN885
910 PRINT"WILL FERTILITY (1) STAY AT";B2;" OR (2) CHANGE SLOWLY"
915 PRINT"TO A NEW LEVEL";
920 INPUTZ
925 IF(Z-1)*(Z-2)<>0THEN910
930 IFZ<>1THEN980
935 PRINT"WHAT FERTILITY WILL BE STABLE";
940 INPUTB3
945 IFB3<0THEN935
950 PRINT"HOW MANY DECADES UNTIL FERTILITY REACHES";B3;
955 INPUTY3
960 IFY3<=0THEN950
965 IFY3*2<>INT(Y3*2)THEN950
970 LETJ=(B3-B2)/(Y3*2)
975 LETY3=Y3*2+Y1
980 RETURN
985 PRINT"PERCENT FEMALE BIRTHS";
990 INPUTM
995 LETM=1-M/100
```

89

```
1000 IFABS(M-.5)>.5THEN985
1005 RETURN
1010 PRINT"PCT. FERTILITY OCCURING IN FEMALES AGES:"
1015 LETT=0
1020 FORN=3TO10
1025 IFN=10 THEN 1040
1030 PRINT(N-1)*5;"-";N*5-1;
1035 GOTO1045
1040 PRINT" 45 AND OLDER";
1045 INPUTB(N)
1050 LETB(N)=B(N)/100
1055 LETT=T+B(N)
1060 NEXTN
1065 IFABS(T-1)<.02THEN1080
1070 PRINT"TOTAL MUST BE 100"
1075 GOTO1015
1080 RETURN
1085 LETI=3
1090 PRINT"CHANGE IN MORTALITY OCCURING IN FEMALES"
1095 GOSUB1145
1100 LETI=4
1105 PRINT"CHANGE IN MORTALITY OCCURING IN MALES"
1110 GOSUB 1145
1115 RETURN
1120 LETI=1
1125 PRINT"CHANGE IN FEMALE POPULATION"
1130 GOSUB 1145
1135 LETI=2
1140 PRINT"CHANGE IN MALE POPULATION"
1145 PRINT"GROUPS (FROM AGE, TO AGE)";
1150 INPUTQ,Q1
1155 IFQ=Q1THEN1315
1160 LETQ=INT(Q/5)+1
1165 LETQ1=INT(Q1/5)+1
1170 IFQ1<QTHEN1145
1175 IFQ<1THEN1145
1180 IFQ1<16THEN1190
1185 LETQ1=16
1190 PRINT"GROUP","CURRENT","NEW VALUE"
1195 IF I<3 THEN 1210
1200 PRINT" ","DEATH/1000"
1205 GOTO 1215
1210 PRINTTAB(9);"POPULATION MILLIONS"
1215 FORN=QTOQ1
1220 IFN=16THEN1235
1225 PRINT(N-1)*5;"-";N*5-1,
```

```
1230 GOTO1240
1235 PRINT"75 AND OVER",
1240 IF I<3 THEN 1255
1245 PRINT1000-INT(M(I,N)*1E4+.5)/10," ";
1250 GOTO 1260
1255 PRINT INT(M(I,N)/1E5+.5)/10," ";
1260 INPUT Z2
1265 IFI>2THEN1285
1270 IFZ2<0THEN1220
1275 LETM(I,N)=Z2*1E6
1280 GOTO1310
1285 LET M(I,N)=1-Z2/1E3
1290 IFM(I,N)<=1THEN1300
1295 LETM(I,N)=1
1300 IFM(I,N)>=0THEN1310
1305 LETM(I,N)=0
1310 NEXTN
1315 RETURN
1320 DATA2.45
1325 DATA.002,.143,.338,.285,.147,.066,.018,.001
1330 DATA.515
1335 DATA8.430E6,9.749E6,10.209E6,9.492E6,8.531E6,6.931E6
1340 DATA5.834E6,5.703E6,6.116E6,6.293E6,5.747E6,5.221E6
1345 DATA4.612E6,3.756E6,3.263E6,4.697E6
1350 REM - MALE POPULATION FIGURES
1355 DATA8.753E6,10.127E6,10.596E6,9.793E6,8.645E6,6.827E6
1360 DATA5.686E6,5.505E6,5.802E6,5.917E6,5.312E6,4.771E6
1365 DATA4.044E6,3.075E6,2.372E6,2.994E6
1370 REM FEMALE MORTALITY 5 YEAR SURVIVAL RATES
1375 DATA.982188,.997241,.998528,.997810,.996649,.996013
1380 DATA.994799,.992589,.988883,.983307,.975232
1385 DATA.965217,.948579,.921060,.878601,.662675
1390 REM MALE MORTALITY
1395 DATA.977536,.996465,.997803,.995070,.990384
1400 DATA.989478,.989692,.987119,.981037,.970752,.954883
1405 DATA.930882,.893099,.843550,.779330,.590070
1410 PRINT
1415 PRINT "ANOTHER PROJECTION (1=YES, 0=NO)";
1420 INPUT Q
1425 IFQ=1THEN125
1430 END
```

E. Program Variables

This partial listing includes only the most important variables.

Program Symbol	Formula Symbol	Meaning
B	f	Fertility
B(N)	D_i	% Fertility expressed in each cohort
I		Index for M(I,N)
I9		Net immigration
M	m	% Male births
M(1,N)	F_i	Female cohort population
M(2,N)	M_i	Male cohort populations
M(3,N)	S_i	Female cohort survival*
M(4,N)	T_i	Male cohort survival*
N	i	Cohort index
Q	B	Births
R		Report format
T	T	Total population
Y1		Year counter
Y2		Year at start of projection

*Within the program, survival rather than mortality rates are used.

F. Altering *USPOP*

1) Elimination of immigration is required if you are to model regional populations. Also this effect is desirable for ZPG studies, as most zero population growth studies ignore immigration.

To eliminate immigration, delete the following lines from *USPOP* before running the program:

52Ø	565
525	57Ø
55Ø	58Ø
555	

2) Updating *USPOP* can be carried out whenever new data becomes available from the Bureau of the Census but since *USPOP* examines population only in 5-year intervals, it is suggested that the first update be made for 1975. After one updating, the new figures become the standard fertility, birth distribution, mortality, and population size.

All the required data is available through the Department of Commerce, Bureau of Census Publication: *CURRENT POPULATION REPORTS, PROJECTION OF THE POPULATION OF THE UNITED STATES BY AGE AND SEX*. The current series is P-25.

a) Fertility - the fertility used in *USPOP* is total fertility. This number is stored in line number 132Ø. To update, replace the old number with the more current fertility.

b) Birth distribution is obtained by totalling the age specific fertilities and then dividing each age specific fertility by the total. To update, replace the numbers in line 1325. The division product of ages 10-14 is written first, and that of ages 45-50 is last. Each number must be separated by a comma.

c) Sex ratio - the per cent of male live births is stored in line 133Ø in decimal form. To update, just replace the old number with the new one.

d) Populations

i) Female - the populations of the 5-year age categories: 0 to 4, 5 to 9, ... 70 to 75, and 75 and over are stored in lines 1335, 134Ø, and 1345. The population of females 0 to 4 is stored first, and the population of those females 75 and over is stored last.

ii) Male - the populations of the male 5-year age categories are similarly stored in lines 1355, 1360, and 1365.

To update populations, replace each old number with its new equivalent.

e) Mortality - *USPOP* uses 5-year survival rates rather than 5-year mortality rates to figure the program as "Five-year Survival Rates for the Total Population by Sex."

i) Female - this information is stored in lines 1375, 1380, and 1385; the youngest category first (0 to 4) and the oldest category (75 and over) last.

ii) Male - survival rates are stored in lines 1395, 1400, and 1405 in a similar fashion.

To update mortality, replace each old value with its new equivalent.

V. ADDITIONAL STUDENT PROJECTS USING *USPOP*

Before attempting these projects, you would be well advised first to carry out at least one of the experiments found in the *USPOP STUDENT MANUAL*. The projects described here require considerable skill in framing an experiment and in carrying the experiment out. The skills and experiences gained in performing the experiments in the *STUDENT MANUAL* will definitely be an aid.

Very little in the way of procedure will be indicated for these projects. As an investigation, you should attempt to discover your own method of solution whenever possible.

PROJECT 1 AN INVESTIGATION OF ZERO POPULATION GROWTH.

Zero population growth (ZPG) is a movement that has been attracting much attention in the news media lately. Advocates of this movement maintain that the United States should reduce its fertility to slightly above 2 children per woman. (The actual number must be slightly more than 2 to account for female mortality before reaching childreating ages.)

For your investigation, you can make the following assumptions:

1) Birth distribution, sex ratio of offspring, mortalities and populations remain unchanged throughout the entire time period of the investigation.

2) The downward trend in fertility starts in the year 1970, but the desired fertility is not reached until some time later. When ZPG is achieved, fertility stabilizes; that is, once the fertility falls to 2.0, it stays there.

3) The fertility in the year 1970 is 2.45. (If you answer "yes" to the question "DO YOU ASSUME STANDARD FERTILITY?", you will automatically be given a 1970 fertility of 2.45.)

The problem that you must investigate is:

GIVEN THE ABOVE ASSUMPTIONS, WHAT PATTERN OF GROWTH IN THE UNITED STATES WILL BE EXPECTED SHOULD ZPG BE ATTAINED IN 1980? 1985? 1990? 1995? or 2000? IN WHAT YEARS CAN WE EXPECT A LEVELING OFF OF THE POPULATION? IS IT OF MAJOR IMPORTANCE THAT WE GO TO ZPG?

All your answers should be carefully documented with results from your computer runs. (Remember *USPOP* assumes 2 million immigrants for each 5-year period. If you wish to subtract them, see Section IV, Part F.)

PROJECT 2 AN INVESTIGATION OF POPULATION MAINTENANCE.

If you carried out *PROJECT 1*, you probably found that even if we were to reach ZPG immediately, the population would continue to grow for quite a long time. Demographers have been concerned about this, not so much for the U. S., but for other countries where this continued growth may prove disastrous; so they have used computer models similar to *USPOP* to investigate what changes in fertility would be necessary to maintain population at current levels. In this project, you are to devise a program that will keep population at 1970 levels as closely as possible, by adjusting the fertility as often as necessary.

You can make the following assumptions:

1) Birth distribution, sex ratio of offspring, mortalities and populations remain unchanged during the entire period of the investigation.

2) Fertility in the year 1970 is 2.45.

3) You, as planner, have total control over fertility.

The problem that you must investigate is:

WHAT CHANGES IN FERTILITY MUST BE MADE BETWEEN 1970 AND 2050 IF THE U. S. IS TO MAINTAIN A CONSTANT POPULATION?

Finding a solution may require many runs; keeping very careful records of which approach worked and which didn't would probably pay off. You may find it easiest to work on a single 10-year period at a time.

PROJECT 5 A COMPLEX PROJECTION OF FUTURE POPULATION GROWTH.

In all past simulations you have been restricted to varying only one factor at a time. In this simulation you are free to vary any and all factors over the entire period of projection. The one major restriction is that you must attempt to be as realistic as possible; you must change variables in a realistic way, realistic both to you and to authorities in the field of population planning.

You can begin designing your projection by first plotting out what changes are likely to occur, and when. To help you do this, first read over the introductory section of the *STUDENT MANUAL* and record your thoughts as to the likelihood of each of the events. After you have formed your own opinions, consult at least one of the texts or articles in the SUPPLEMENTARY READINGS section of this Manual, to check your opinions against those of an expert. You may then alter your projection or match your projection against the expert's.

Your only restrictions are to:

1) Assume that the 1970 data is valid for 1970.

2) Be prepared to defend each of your assumptions.

VI. SUPPLEMENTARY READINGS AND FILMS

BOOKS

Erlich, Paul R.
THE POPULATION BOMB
Ballantine Books, New York, 1968

The widely read plea of a scientist, likened by many to a 20th century Malthus.

MacArthur, Robert and Connell, Joseph
THE BIOLOGY OF POPULATIONS
John Wiley and Sons, Inc., New York, 1966

Although concerned primarily with animal populations, the authors do use human examples throughout the text. A mathematical treatment is used.

Malthus, Thomas Robert (1766-1834)
FIRST ESSAYS ON POPULATION
Macmillan, New York, 1966

Facsimile reprinting of a Malthus work originally published in 1789.

Malthus, Thomas Robert (1766-1834)
ON POPULATION
Modern Library, New York, 1960

Reprinting of Malthus' most famous essay.

Meadows, Dennis L. et al
LIMITS TO GROWTH
Potomac Associates, Universe Books, New York, 1972

Highly controversial analysis of future growth, based on computer projections.

Taylor, Gordon Rattray
THE BIOLOGICAL TIME BOMB
Signet Edition (paperbound), New American Library, New York, 1968

Lively, stimulating and speculative treatment of the changes that technology and science can be expected to make in man before the year 2000. Subjects discussed include: choice of sex in offspring; fertility control; cryogenics; human genetic engineering; creation of life; and many other areas of high student interest.

COLLECTIONS OF ESSAYS AND/OR REPORTS

THE ECOLOGY OF MAN: AN ECOSYSTEM APPROACH
Edited by Robert Leo Smith
Harper and Row, New York, 1972

Part IV of this paperbound book deals with human population problems. Editor gives a simple mathematical explanation; commentaries from others working in the field follow. Most commentaries are non-mathematical. Nicely balanced readings for the student.

THE POPULATION DILEMMA
Edited by Philip M. Hauser
Prentice-Hall, Englewood Cliffs, N. J., 1963

Collection of papers designed for the general reader.

SYMPOSIA ON QUANTITATIVE BIOLOGY, Vol.XXII, 1967
Biological Laboratory, Cold Spring Harbor, New York

Series of scientific articles concerned with many aspects of demography. Those dealing with human population are easy to read and require little mathematical skill. Good source of readings for the advanced student. (Many of the interpretations of the scientists can be tested by using *USPOP*.)

UNITED NATIONS AND UNITED STATES GOVERNMENT PUBLICATIONS

United Nations Department of Economic and Social Affairs
WORLD POPULATION SITUATION IN 1970
United Nations Sales Section ($2.00), New York 1971

Bureau of Census
COUNTY AND CITY DATA BOOK 1967
U. S. Government Printing Office, Washington, D. C, ($7.75)

Population data for each county and many larger cities within the United States.

Bureau of Census, Current Population Reports Series P-25, No. 454
INVENTORY OF STATE AND LOCAL AGENCIES PREPARING POPULATION ESTIMATES
U. S. Government Printing Office, Washington, D. C. (50¢)

This is of special interest to those planning to use *USPOP* for modeling local populations.

Bureau of Census, Current Population Reports Series P-25, No. 493
PROJECTION OF THE POPULATION OF THE UNITED STATES BY AGE AND SEX
U. S. Government Printing Office, Washington, D. C., 1972 (35¢)

The latest government projections together with non-technical explanations of assumptions used. Useful for further ideas for using *USPOP*.

Bureau of Census, U. S. Department of Commerce
STATISTICAL ABSTRACT OF THE UNITED STATES 1971
U. S. Government Printing Office, Washington, D. C. ($5.50)

An amazing compilation of statistics relevant to most areas of American life. A good source for current information on demographic figures. Published annually. This is the major source used for the data held in *USPOP* data statements.

CONGRESSIONAL DISTRICT DATA (for the 92nd Congress)
U. S. Government Printing Office, Washington, D. C.

Individual data available for each state's congressional districts. The cost is 25¢ per state, except for New York and California: 50¢. Excellent source of information for those teachers wishing to model their local areas with *USPOP*.

Department of Health, Education and Welfare
LEADING COMPONENTS OF UPTURN IN MORTALITY FOR MEN, UNITED STATES, 1952-1967
DHEW Publication No. (HSM) 72-1008
U. S. Government Printing Office, Washington, D. C. (50¢)

Statistical data and text exploring reasons for the upturn in mortality in men. (The U. S. was one of only three countries in the world that has shown an upturn for male mortality during this period.)

HISTORICAL STATISTICS OF THE UNITED STATES: COLONIAL TIMES TO 1957;
Continuation to 1962 and Revisions.
U. S. Government Printing Office, Washington, D. C., 1965 ($1.50)

Good investment for social studies teachers interested in exploring a historical approach to population projection.

U. S. Agency for International Development (A.I.D.)
POPULATION PROGRAM ASSISTANCE
U. S. Government Printing Office, Washington, D. C., 1971 ($2.00)

Review of population control programs in each country receivin U. S. assistance.

REPORT OF THE U. S. COMMISSION ON POPULATION GROWTH AND THE AMERICAN FUTURE
Available from:
New American Library, New York
or
U. S. Government Printing Office, Washington, D. C.

Details of findings relevant to all aspects of American life.

ARTICLES FROM POPULAR PUBLICATIONS 1972

"Crucial Math of Motherhood"
LIFE 72: p.46-50, 5/19/72.

"Conservative Reacts: Elements of Population Policy"
W. Petersen, *NATIONAL REVIEW* 24: p.520-1, 5/12/72.

"Falling Fertility Rates"
NEWSWEEK 79: p.75, 6/19/72.

"Where Does the Planet Go From Here?"
NEWSWEEK 79: p.54-5, 6/12/72.

"Population: The U. S. Problem, the World Crisis"
Supplement to *THE NEW YORK TIMES*, 4/30/72.

Contains statements by world leaders concerning population growth. Included are Richard M. Nixon; Martin Luther King, Jr.; Theodore Hesburgh; Kurt Waldheim and others.

"A Woman Anthropologist Offers a Solution to the Woman Problem"
THE NEW YORK TIMES MAGAZINE, 8/27/72, p.7.

Uses demographic information to analyze change in female attitude.

"Free Abortion for All?"
TIME 99: p.71, 3/27/72.

Reaction to U. S. Commission on Population Growth Report.

"Ways to Cut the U. S. Birthrate, Findings of an Official Study"
U. S. NEWS AND WORLD REPORT 72: p.64, 3/27/72.

"What Birthrate Means to the America of Year 2000"
U. S. NEWS AND WORLD REPORT 72: p.45-6, 3/20/72.

"Where Will Americans Live in 1990?"
U. S. NEWS AND WORLD REPORT 72: p.36-7, 4/10/72.

SELECTED AUDIO-VISUAL

16mm Film Sound

PEOPLE BY THE BILLIONS
National Film Board of Canada, 1960
29 Minutes

Filmstrips 35mm

CRISIS OF THE ENVIRONMENT
The New York Times Office of Educational Activities, 1969
Set of 5 filmstrips with sound

POPULATION EXPLOSION
The New York Times Office of Educational Activities, 1967